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IVIS OPERATIONAL CONCEPT

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IVIS OPERATIONAL CONCEPT

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The author presents the concept for the use of a near to mid term Intervehicular Information System (IVIS). The concept is intended to describe the IVIS in terms of intravehicular and intervehicular capabilities. The concept describes the use of IVIS at the individual, platoon, company/team, battalion/task force, and brigade echelons. Use of the IVIS in a team or task force organization is based on the capability of all members of the fighting organization to share "IVIS like" information. The concept focuses on use of the IVIS pre/post combat and during mission execution. It is anticipated that IVIS capabilities will be used similarly before and after contact with the enemy, but in a significantly different manner during actual mission execution. The concept provides the reasons for the distinctive use of the system during each phase of the mission, as well as some examples of how it might be used at the various levels of command and control within the task force.

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[illegible] of this concept should not be used as a [illegible] reference. Most of the concept is fundamentally based on existing doctrine and procedures as listed in Field Manuals 71-1,-2, and -3, Fort Knox Supplemental Material 17-15-3 (Tank Platoon SOP) and 17-16 (Company/Team SOP), and Special Text 17-17 (Combined Arms Heavy Battalion/Task Force SOP). Those areas within the concept that may conflict with current doctrine are no more than illustrations of how an "IVIS capable" unit might communicate, plan, and execute combat missions. This concept does not eliminate the need to develop appropriate tactics, techniques, and procedures for the use of IVIS at the platoon, company/team, battalion/task force, and brigade tactical levels.

EXECUTIVE SUMMARY

1. Introduction.

A. The Intervehicular Information System (IVIS) will provide near real-time acquisition, processing, and distribution of combat data and information to enable the integration of combat, combat support, and combat service support assets of the combined arms task force and cavalry squadron. The IVIS is a milestone on the path to an integrated, mounted Combined Arms Team - a team that is on the verge of a quantum improvement in battle space command and control. The IVIS will contribute to a dramatic improvement in force effectiveness through the integration of battlefield "sensors" (reconnaissance and fighting vehicle systems, forward observers, etc.), more rapid exchange of command and control information at levels brigade/regiment and below, enhanced navigation, and improvements in force sustainability.

B. The introduction of the IVIS to the tank is expected to provide an exponential increase in the ability of the commander and staff to plan, execute, and support missions, as well as enhance the ability of the crew to acquire, engage, and destroy enemy targets. Commanders will use IVIS capabilities to:

- *Speed the plans-orders cycle;*

- *Improve battlefield lethality by more rapidly maneuvering combat power to the decisive point on the battlefield, and by more rapid and accurate application of indirect fires against the enemy.*

- *Improve force survivability through reduced force density while still massing direct and indirect fires; and*

- *Enhance situational awareness on the battlefield as a result of knowing the locations of all other vehicles and their assigned targets on a virtual real time basis (without recourse to voice transmissions over the radio). Enhanced situational awareness will also provide a residual payoff in terms of fratricide reduction.*

The IVIS provides just one aspect of evolving battlefield dynamics. As such, the capabilities of IVIS represent the most significant step in improved battlefield command and control of the mounted combined arms team since the installation of radios in tanks in the 1930's.

2. Purpose. The purpose of this paper is to provide the reader with an appreciation of the potential tactical benefit

of the IVIS at the individual vehicle, platoon, company/team, and battalion/task force levels of command and control (C2). The paper outlines the tactical applications of the IVIS with respect to:

- *Command and control of forces/combat elements at the battalion/task force, company/team, and platoon (including individual vehicle) levels (contributes to synchronization and agility);*

- *Enhancing coordination and execution of combat, combat support, and combat service support (contributes to synchronization, initiative, and agility);*

- *Speeding the mission planning process at all levels of C2 within the Armor battalion/task force (contributes to synchronization and agility); and*

- *Enhancing the situational awareness (friendly and enemy) of decision makers and fighters at battalion and below C2 echelons (contributes to synchronization and agility).*

This paper describes IVIS capabilities in terms of what can be achieved with technology in the near-to-mid terms (next 10 years). The IVIS is expected to be "linked" to the command and control (C2) systems of combat, combat support, and combat service support elements in order to provide maximum tactical benefit to the mounted combined arms team. The ability to exchange a common set of graphics, messages, and orders will provide the means for integrating the C2 systems of the combined arms brigade (Engineers, Field Artillery, Air Defense, Aviation, and Combat Service Support), and could be used for automated command and control in both joint and coalition force structures.

3. Intervehicular Information Sharing. The M1A2 tank will have the capability to share tactical information and data with vehicles that are equipped with "compatible" software, processing systems, and output devices (display screens). The concept of sharing tactical information does not mandate the use of the same system components within the M1A2. Taken as a generic term, "IVIS" can also represent the exchange of command and control data and information among combat, combat support, and combat service support elements of a combined arms organization. Information and data sharing among combat, CS, and CSS leaders and command posts is based on the ability to transmit and receive IVIS reports, messages, and graphic overlays that contribute to the command and control of the tactical organization (platoon, company/team, and battalion/task force). Essential for information sharing within the combined arms team is common **technical** capability to transmit and receive similarly "formatted" digital messages (tactical messages, reports, and graphics/overlays). Application software, within the automated command and control

systems that exist at the company/team, battalion/task force, and brigade levels, must have the capability to "understand" the data format of those messages transmitted or received using the SINCGARS. Display of these messages is normally provided on the system hardware that is integral to the automated command and control system of the sender or receiver. Display hardware can range from the M1A2's CID to any Army Command and Control System (ACCS) common hardware device or terminal.

4. Use of the Intervehicular Information System Within the Armor Battalion/Task Force.

A. *General*. The IVIS is just one system within a family of C2 systems. As such, it is expected to interface with its parent system used at higher command echelons, and with the C2 systems that might be routinely located within the organization of the Armor task force or Cavalry squadron. The need for interface with other systems is based on the central operating principle of the IVIS - the mutual sharing of tactical data and information within the combined arms team. The intent of developing an IVIS interface with other C2 systems is not to provide the "IVIS" to non-IVIS equipped vehicles within the task force, but rather to establish a common "bridge" by which to exchange data and information essential to mission planning and execution.

B. *Data and information exchange within the task force*. In the absence of an automated C2 system, elements of the combined arms team are required to transmit situational (tactical and logistic/administrative) data by FM voice radio. The means of sharing data and information within the organization is based on members of the unit (platoon, company/team, task force or squadron) operating and eavesdropping on established, doctrinal radio networks. This concept changes dramatically with the introduction of a C2 system such as IVIS. Under IVIS, the sharing of automated C2 data and information is limited to only those systems equipped with IVIS hardware and software, or those that have the capability to transmit and receive IVIS messages. In some cases, information and data display capabilities may be somewhat different from that of the vehicle or unit commander in an IVIS equipped tank. What is important however is that whatever the means of information display that a member of the combined arms team uses, the display must be able to convey the **data and information** required by that member of the team (tank company commander, fire support officer, engineer platoon leader, etc.) to perform its combat, combat support, or combat service support mission and tasks.

C. *IVIS definition modes*. The tank's IVIS operates in three different operational modes: Pre/post combat, combat, and diagnostics. System functions and displays differ based on the mode selected by the vehicle commander. All three modes offer a varying degree of reporting (IVIS messages) and

planning (graphics). This paper discusses the use of the IVIS when in the pre/post combat and combat modes.

D. *Pre/post combat.* The conditions of the pre/post combat phases typically are such that the individual **vehicle or unit commander has sufficient time** to manually enter into the IVIS admin/log reports the degree of detail that both the 1SG and the Combat Trains Command Post (CTCP) require for eventual entry into the battalion's automated C2. Reports are sent IAW the unit tactical SOP. The staff in the CTCP receives the reports from unit 1SGs through an "interface" between IVIS and its parent C2 system, the IVIS data typically being "translated" into the message format of the parent system, stored in the S-4's system database, and displayed in the format of the staff's C2 system. Storing the data in the format of the higher level system allows the S-4 and S-1 to consolidate task force admin/log data in the format that they must use in order to transmit their own reports to higher headquarters.

E. *Combat.* The use of the IVIS begins to change significantly as the task force elements begin to transition from the pre-combat, or mission preparation phase, to the mission execution phase of the operation. The primary reason for the transition is the **change in focus of the combat elements.**

1. As the task force draws nearer to the enemy, the focus of the combat and combat support elements shifts to the area in which they can employ their direct or indirect fire weapon systems. Even though the staff continues to provide the task force and company/team commanders with the picture of the tactical situation well beyond the task force area of interest (through sensor input from elements at levels brigade and above), the area of interest of the majority of the weapon systems (which are also the primary source of near-in tactical data) is chiefly the area in which they can observe through their direct view optics. This will have an impact on ways in which tactical data is forwarded up through the structure of automated tactical C2 systems within the task force organization.

2. The development and transmission of graphics using IVIS, and its interface with the battalion and other level automated C2 systems within the task force continues to provide a significant enhancement to the current method of updating the commander with a picture of the battlefield situation. The development of graphics by the vehicle and unit commanders within the company/team drops off significantly from that of the pre-combat phase. The staff, however, continues to develop graphic overlays on its system that provide the commander and his subordinate commanders with an easy to interpret picture of

the tactical situation. The TOC to IVIS interface provides the means of transmitting the staff developed graphics to the commander in his tank.

3. Graphics developed at the TOC and transmitted to the commander, S-3, and subordinate commanders also provide the task force with the capability to quickly and effectively change unit missions. This capability is especially effective for units on the move, and does not require the assembly of the task force orders group in order to provide graphics and/or a Fragmentary Order (FRAGO) execution matrix.

4. *Summary - combat.* The tactical conditions that IVIS equipped combat vehicle commanders face once contact with the enemy has been made make routine use of the IVIS, at least in the *manual* mode, difficult at best. During combat, the system is intended to **augment** the vehicle and unit commander's situational awareness. The automated functions that IVIS is capable of performing for the vehicle/unit commander significantly reduce tactical reporting requirements, especially position reporting.

5. Conclusion. The design of any command and control system for use in a combat vehicle must be such that it reduces the cognitive and physical workload of the individual vehicle commander, while simultaneously providing a means of exchange for tactical data and information. The IVIS does this by transmitting and displaying data and information that is essential in the commander's decision-making process. As a computer, the IVIS has built-in capabilities that individual vehicle and unit commanders can use to perform tasks and assist decision-making during the pre/post combat and combat phases of a mission. Proper training and fully developed tactics, techniques, and procedures, from vehicle to task force level, lay the groundwork for effective use of the IVIS. Understanding what the system can do for the vehicle and unit commander (under battlefield conditions that range from intense enemy contact to relative calm) must exist not only among the commanders that fight from IVIS equipped vehicles, but with the supporting elements at company/team and battalion/task force level alike. To realize the **full potential of IVIS**, it is essential that the system "interface" with the automated command and control systems of supporting elements at the company/team (ISG, FIST, Engineer Platoon/Section leader, etc.) and task force (TOC and CTCP) levels. Interface with other systems is based on the exchange of data and information that is essential to the performance of pre/post combat and combat tasks by combat, combat support, and combat service support elements. Creating these interfaces is critical to fielding a system that significantly increases the exponential benefit and effectiveness that the IVIS can provide to command and control at the battalion and below level of war.

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1. Introduction.

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3. M1A2 Tank System Description. The architecture of the IVIS on the M1A2 tank is composed primarily of 4 major components. These components include: Commander's Independent Thermal Viewer, Improved Commander's Weapons Station, Position Navigation (POSNAV) System, and the core tank/data bus architecture. Each of these components is described in detail in Annex A.

4. Core Tank and the Intervehicular Information System (IVIS).

A. *Intravehicular Information Sharing.*

1. *General.* The description of the core tank at Annex A illustrates the architecture that provides a mechanical basis for the IVIS concept. IVIS is not a single component nor is it an architecture of component subsystems. Rather, IVIS is the **conceptual and technical sharing of data** within the M1A2 tank. The core tank provides the system architecture upon which data is "shared" among tank "intra-vehicular" system components.

2. Intravehicular information/data sharing provides a more robust and efficient means of operating the tank's integral components and systems, and offers significant growth capability and potential over the current system architecture

of the M1A1 tank (Figure 1). Changes to software provide a means of enhancing the tank system where it might have once been necessary to replace complete sets of component circuit cards.

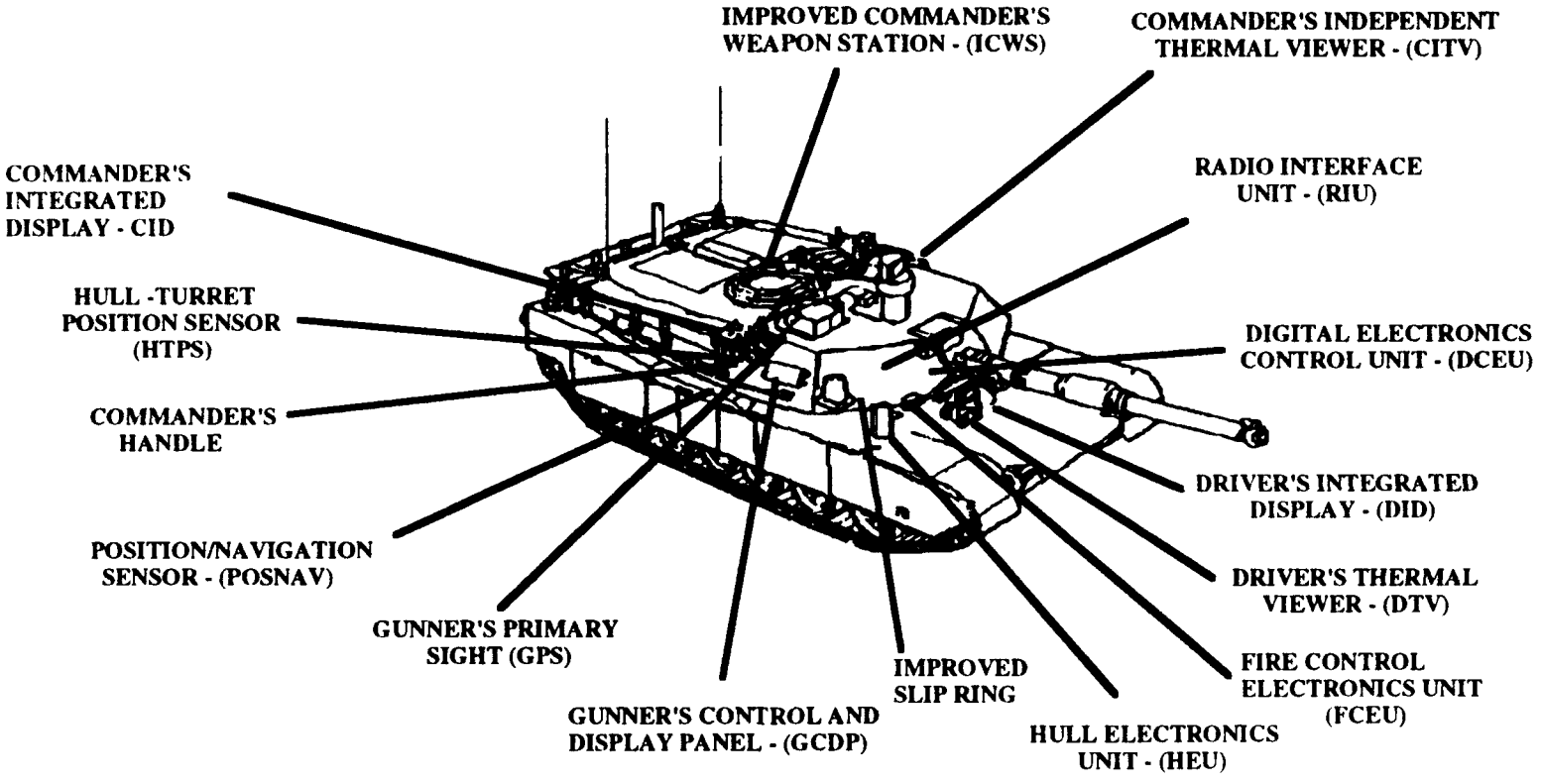
3. The data/power bus architecture of the M1A2 tank provides flexibility in terms of hardware modifications and enhancements, especially when compared to the current method of "hardwiring" components into the tank and into one another. Reducing the requirements to directly link components together provides residual benefit in terms of reduced space claims (by providing more options for component location within the hull and/or turret). The bused architecture also provides redundancy, with subsequent payoffs in system survivability, since some tank components can actually take over the functions of other components (such as HEU backing up TEU failure). Built-in test and diagnostics also become possible for the tank under a data bus architecture like IVIS.

4. Tank system growth is accelerated when the vehicle is equipped with IVIS. The ability to add hardware systems to the tank, or to update current system software based on input from the field, provides a flexibility (and potential cost savings) that is not found in the current fleet of tanks.

B. *Intervehicular Information Sharing.*

1. *General.* The M1A2 tank also has the capability to share tactical information and data with vehicles that are equipped with "compatible" software, processing systems, and output devices (display screens). The concept of sharing tactical information does not mandate the use of the same system components within the M1A2. Taken as a generic term, "IVIS" can also represent the exchange of command and control data and information among combat, combat support, and combat service support elements of a combined arms organization. Information and data sharing among combat, CS, and CSS leaders and command posts is based on the ability to transmit and receive IVIS reports, messages, and graphic overlays that contribute to the command and control of the tactical organization (platoon, company/team, and battalion/task force). Essential for information sharing within the combined arms team is common **technical** capability to transmit and receive similarly "formatted" digital messages (tactical messages, reports, and graphics/overlays). Application software, within the automated command and control systems that exist at the company/team, battalion/task force, and brigade levels, must have the capability to "understand" the data format of those messages transmitted or received using the SINCGARS. Display of these messages is normally provided on the system hardware that is integral to the automated command and control system of the sender or receiver. Display hardware can range from the M1A2's CID to any Army Command and Control System (ACCS) common hardware device or terminal (Figure 2).

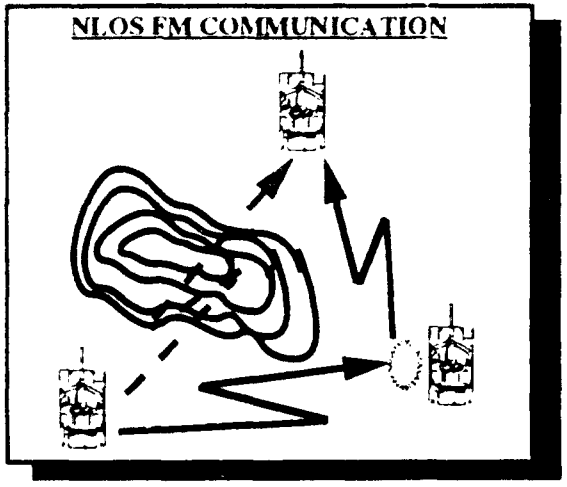
INTERVEHICULAR INFORMATION SYSTEM

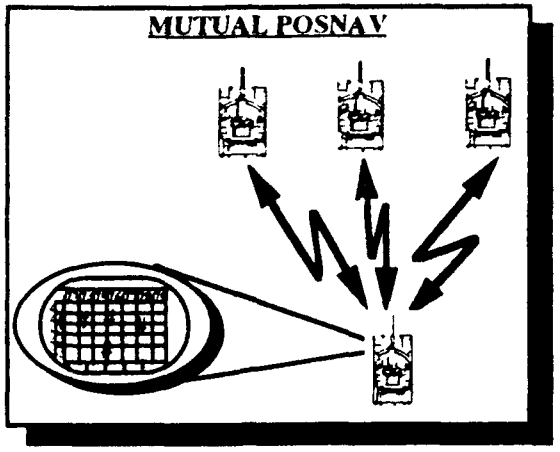


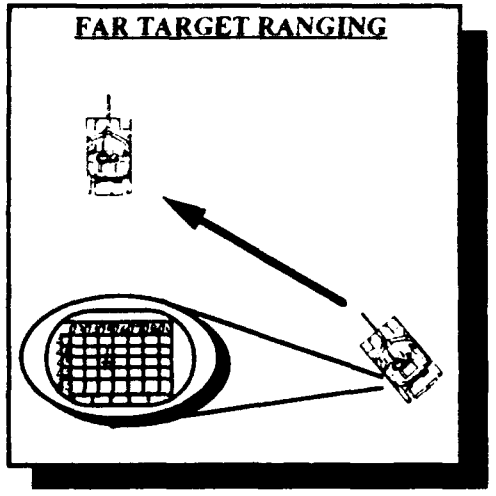
CAPABILITIES

- *NAVIGATION*
- *DIAGNOSTICS*
- *COMMUNICATIONS*
- *MISSION PLANNING*
- *SYSTEM HELP*
- *DATABASE MANAGEMENT*

FIGURE 1. Intervehicualr Information System (IVIS) Architecture







COMMON BATTLEFIELD PICTURE

- *AUTOMATIC POSITION LOCATION OF FRIENDLY VEHICLES / UNITS (MUTUAL POSNAV)*
- *AUTOMATIC FM RETRANS*
- *AUTOMATED SITUATION REPORTING - METT-T*
- *EXCHANGE OF MISSION GRAPHICS AND CONTROL MEASURES*

FASTER
MORE EFFICIENT
MORE EFFECTIVE

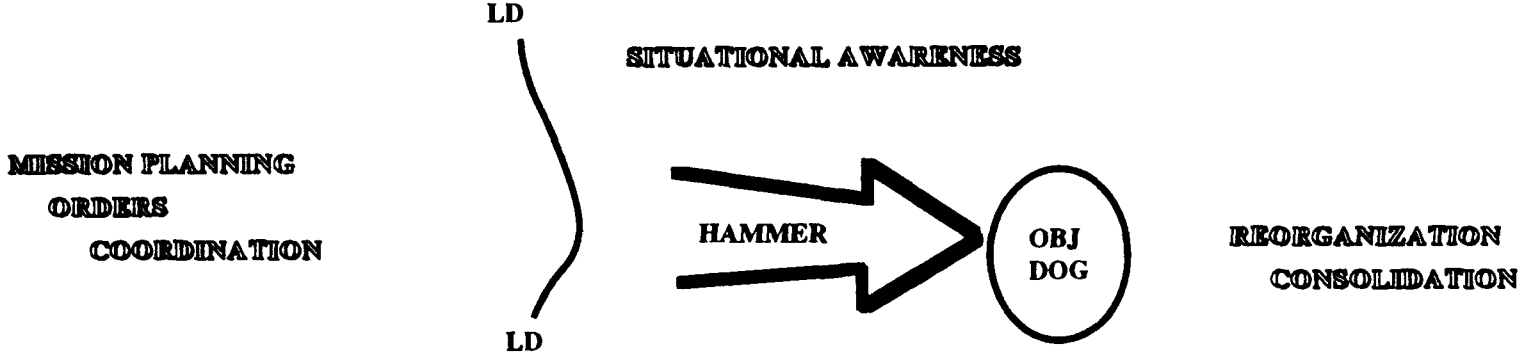


FIGURE 2. Intervehicular Information Sharing

2. *M1A2 IVIS*. The introduction of digital communications and enhanced on-board data processing within the M1A2 tank provides the vehicle and unit commander with revolutionary system improvements over that of the M1A1 tank.

a. *Digital communications*. Digital communications has been added to the Abrams tank (while maintaining voice communications capability) through the incorporation of the Single Channel Ground/Airborne Radio System (SINCGARS). The capability to digitally transmit reports, messages, and graphic overlays between vehicles and commanders more rapidly than with voice communications results in reduced radio transmission times. Shortened transmission times reduces the susceptibility of inter-vehicular communications to enemy Electronic Counter-Measures. The SINCGARS also uses spread spectrum techniques including Frequency Hopping and Pseudo Noise Encoding that further reduce system susceptibility to enemy ECM techniques such as jamming and intercept of mission data/information.

b. *On-board data processing*. The powerful processing capability of the IVIS is capable of tracking and maintaining status of the tank's on-board ammunition quantities, POL levels, and other vehicle parameters needed to sustain the force. The IVIS provides a means to automate status reporting of a vehicle or unit to higher command echelons and support elements alike.

c. *Contributing functions*. The IVIS assists in consolidating tactical information by filtering out multiple reports of the same battlefield event (SPOTREPs, Contact Reports, ...), or by allowing the commander's staff to represent tactical data in a form that is more meaningful to the tactical commander. The system also provides a significant enhancement in tactical communications on the battlefield by means of a non-line of sight relay capability of IVIS messages and reports. The IVIS will also significantly speed up the process by which tactical orders and graphics are developed and distributed on the battlefield.

5. Use of the Intervehicular Information System Within the Armor Battalion/Task Force.

A. *General*. The IVIS is just one system within a family of C2 systems. As such, it is expected to interface with its parent system used at higher command echelons, and with the C2 systems that might be routinely located within the organization of the Armor task force or Cavalry squadron. The need for interface with other systems is based on the central operating principle of the IVIS - the mutual sharing of tactical data and information within the combined arms team. The intent of developing an IVIS interface with other C2 systems is not to provide the "IVIS" to non-IVIS equipped vehicles within the

task force, but rather to establish a common "bridge" by which to exchange data and information essential to mission planning and execution.

B. *Data and information exchange within the task force.* In the absence of an automated C2 system, elements of the combined arms team are required to transmit situational (tactical and logistic/administrative) data by FM voice radio. The means of sharing data and information within the organization is based on members of the unit (platoon, company/team, task force or squadron) operating and eavesdropping on established, doctrinal radio networks. This concept changes dramatically with the introduction of a C2 system such as IVIS. Under IVIS, the sharing of automated C2 data and information is limited to only those systems equipped with IVIS hardware and software, or those that have the capability to transmit and receive IVIS messages. In some cases, information and data display capabilities may be somewhat different from that of the vehicle or unit commander in an IVIS equipped tank. What is important however is that whatever the means of information display that a member of the combined arms team uses, the display must be able to convey the **data and information** required by that member of the team (tank company commander, fire support officer, engineer platoon leader, etc.) to perform its combat, combat support, or combat service support mission and tasks.

C. *IVIS definition modes.* The tank's IVIS operates in three different operational modes: Pre/post combat, combat, and diagnostics. System functions and displays differ based on the mode selected by the vehicle commander. All three modes offer a varying degree of reporting (IVIS messages) and planning (graphics). This paper discusses the use of the IVIS when in the pre/post combat and combat modes.

D. *Pre/post-combat.*

1. *Individual vehicle - mission planning.* The individual vehicle commander uses the IVIS to prepare for upcoming combat missions by:

a. *Developing and storing within the system database selected routes on which the vehicle will travel during the mission.* The vehicle commander develops the routes by entering a series of waypoints through the Commander's Integrated Display (CID). These routes are saved within the system database, and can also be transmitted to the vehicle commander's platoon leader (Figure 3). The vehicle commander may select a predetermined route prior to mission execution and transmit (automatically or semi-automatically using IVIS) the individual waypoints to the driver.

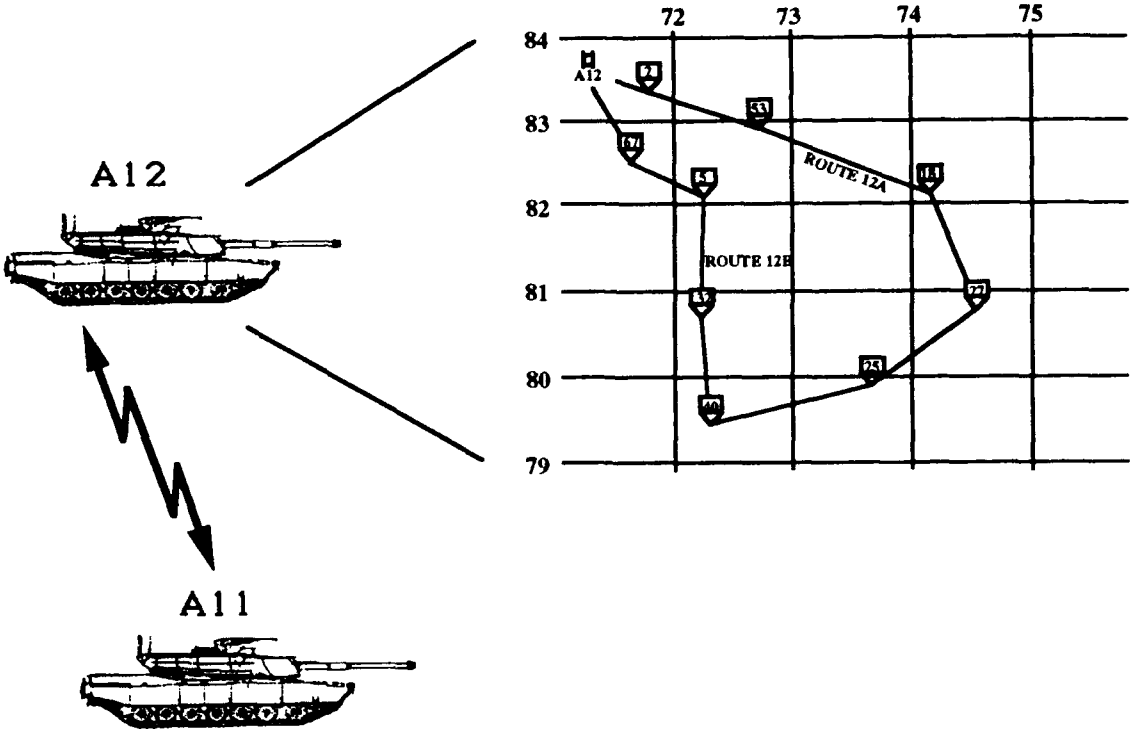


FIGURE 3. Individual Vehicle - Pre / Post Combat - Vehicle Route Planning

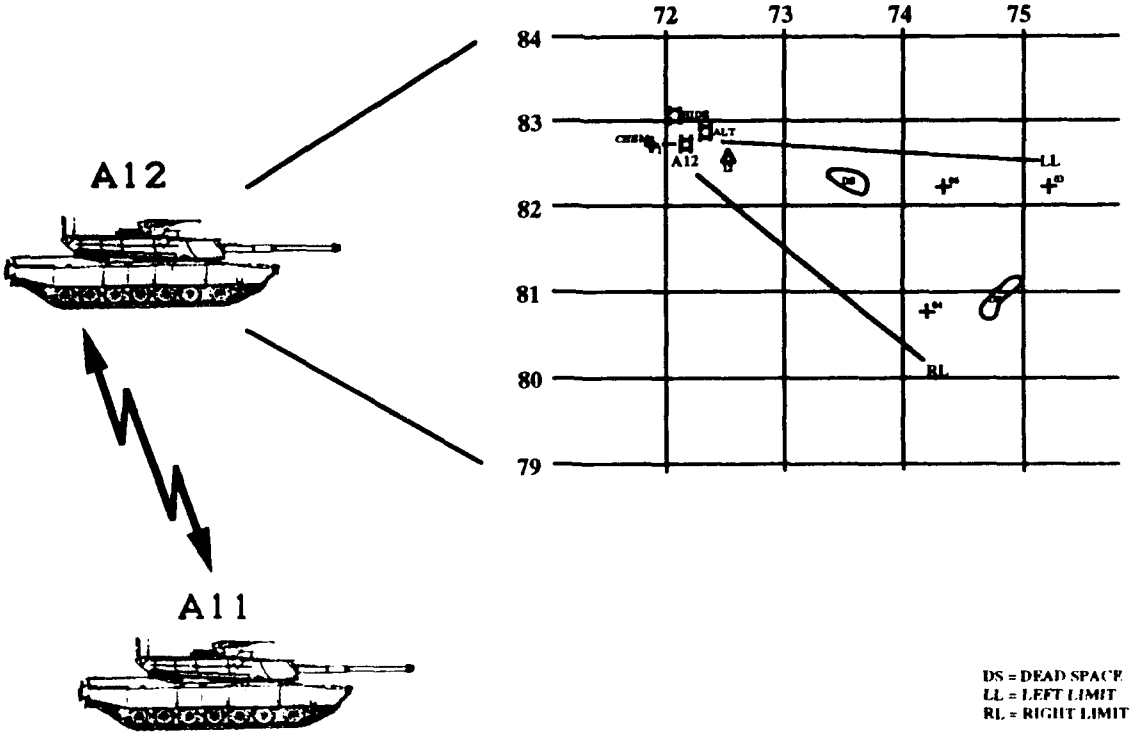


FIGURE 4. Individual Vehicle - Pre / Post Combat - Sector Sketch

b. *Developing vehicle direct fire sector sketch(s) and/or fire plan(s).* The sector sketch/fire plan may include such items as target reference points, left and right limits of fire, location of listening/observation posts, location of chemical agent alarms, dead space not covered by direct fire, and location of vehicle hide positions and primary fighting positions. The vehicle commander transmits the direct fire sector sketch/fire plan to the platoon leader for inclusion into the platoon fire plan (Figure 4).

2. *Individual vehicle - data/information messaging.* The individual vehicle commander uses the IVIS to transmit routine reports at intervals stated in the unit Tactical Standard Operating Procedures (SOPs). Formatting and transmitting of reports can be done automatically, semi-automatically, and manually. Reports that can be formatted and sent automatically require no input by the vehicle crewmen, and transmission of the report is transparent to the crew. Automatic reports can be transmitted based on time-of-day (i.e., transmitted at certain times of the day in accordance with the unit tactical SOP), or when certain preconditions are met within the IVIS (i.e., vehicle on-board fuel level reaches a certain level). Semiautomatic transmission of reports allows the vehicle commander to make the decision of when to transmit the report, but the system itself fills in the report's data fields. Manual transmission of IVIS reports requires the vehicle crewmen to fill in some or all of the report data fields, and then transmit the report to the appropriate receiver.

a. The vehicle's computer will automatically fill in IVIS message elements such as the date/time group of the report, present fuel level, number of main gun rounds remaining, and radio call sign and position location of the sending vehicle.

b. The following reports are capable of being transmitted automatically or semiautomatically with little or no crew action required: Ammunition Status Report (automatically sent when main gun ammo falls to next lower status code or upon receipt of a message requesting an Ammunition Status Report), POL Status Report (upon expenditure of one-eigth tank of fuel, or when fuel reaches each critical level, or upon receipt of a message requesting a POL Status Report), Vehicle Status Report (automatically sent upon receipt of message requesting a Vehicle Status Report), and Position Update (automatically transmitted when the tank has travelled a predetermined distance, or after a predetermined period of time).

c. All other reports contained within the IVIS can be developed and transmitted manually by the vehicle commander in accordance with the tactical situation and the unit's SOP. Transmission of these reports is situationally dependent and

might include any types of alerts (MOPP status change, Air Alert, change in readiness condition, or chemical agent detection), operational reports (Contact, Spot, SITREP, etc.), NBC and Shell reports, and position updates.

3. *Platoon - mission planning.* The platoon leader uses the IVIS to prepare for upcoming combat missions by:

a. *Receiving operational graphics from the company commander.* The platoon leader receives the upcoming mission graphics via inter-vehicular digital transmission using the SINCGARS. By receiving the mission graphics prior to issue of the company Operations Order (OPORD), the platoon leader is able to begin platoon mission planning and coordination while the company commander refines the tactical plan and graphics.

b. *Consolidating individual vehicle direct fire sector sketches/fire plans into a platoon fire plan.* The platoon leader's fire plan may include all the information provided by the individual vehicle commanders, as well as additional control measures and graphics necessary for the command and control of the platoon (Figure 5).

c. *Enhancing mission support graphics.* Additional items within the platoon fire plan/sector sketch may include: the location(s) of obstacles, direct and indirect fire trigger lines, platoon rallying points, coordination points, the location of pre-stocked ammunition, axes of advance/directions of attack, location of battle positions, phase lines, boundaries, assembly areas, attack positions, and platoon objectives. The platoon leader transmits the direct fire plan/sector sketch to the company commander and company Fire Support Officer (FSO) for inclusion into the company direct and indirect fire plans. If the company is supported by combat engineers, the platoon's direct fire plan may also be transmitted to the engineer platoon leader to ensure that direct fires adequately cover all obstacles. This enables the FSO and engineer to begin refining their mission support plans much earlier into the operation than the current practice of exchanging graphics through face-to-face coordination (Figure 6).

d. *Coordinating with lateral units.* If the platoon leader is responsible for coordinating with an adjacent unit, he may enter the adjacent unit's radio net, coordinate a time to meet face-to-face at a predetermined coordination point, and transmit his platoon fire plan for integration into the lateral unit's IVIS database. This enables each unit to become familiar with its adjacent unit's fire plan prior to meeting at the coordination point, allowing the leaders to more quickly concentrate on resolving those areas along the boundary that are not adequately covered by direct fire.

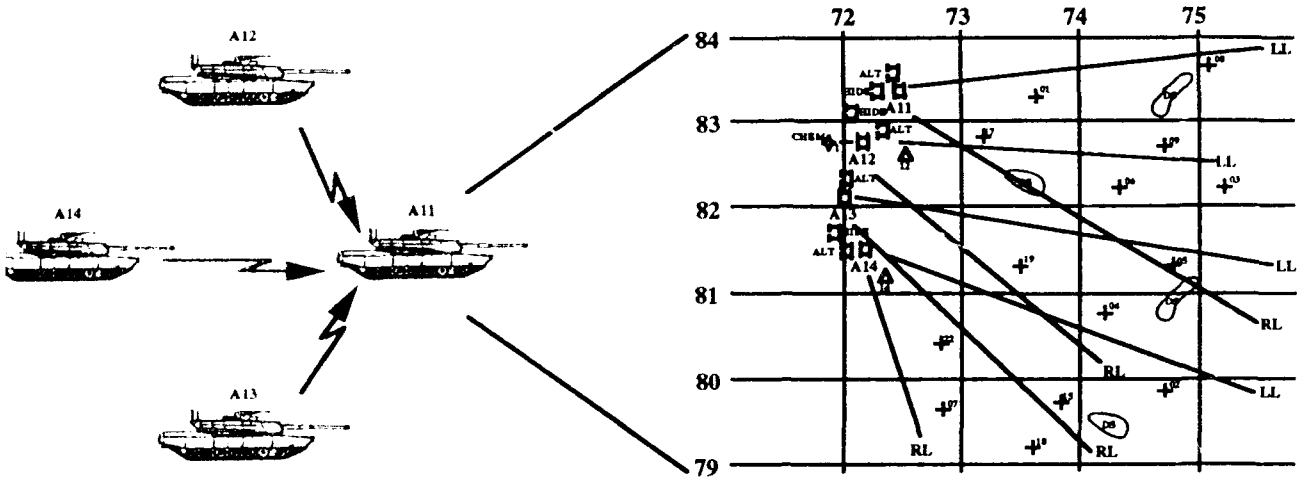


FIGURE 5. Platoon - Pre / Post Combat - Consolidated Vehicle Direct Fire Sketches

DS = DEAD SPACE
LL = LEFT LIMIT
RL = RIGHT LIMIT
TL = TRIGGER LINE
PS = PRE-STOCK

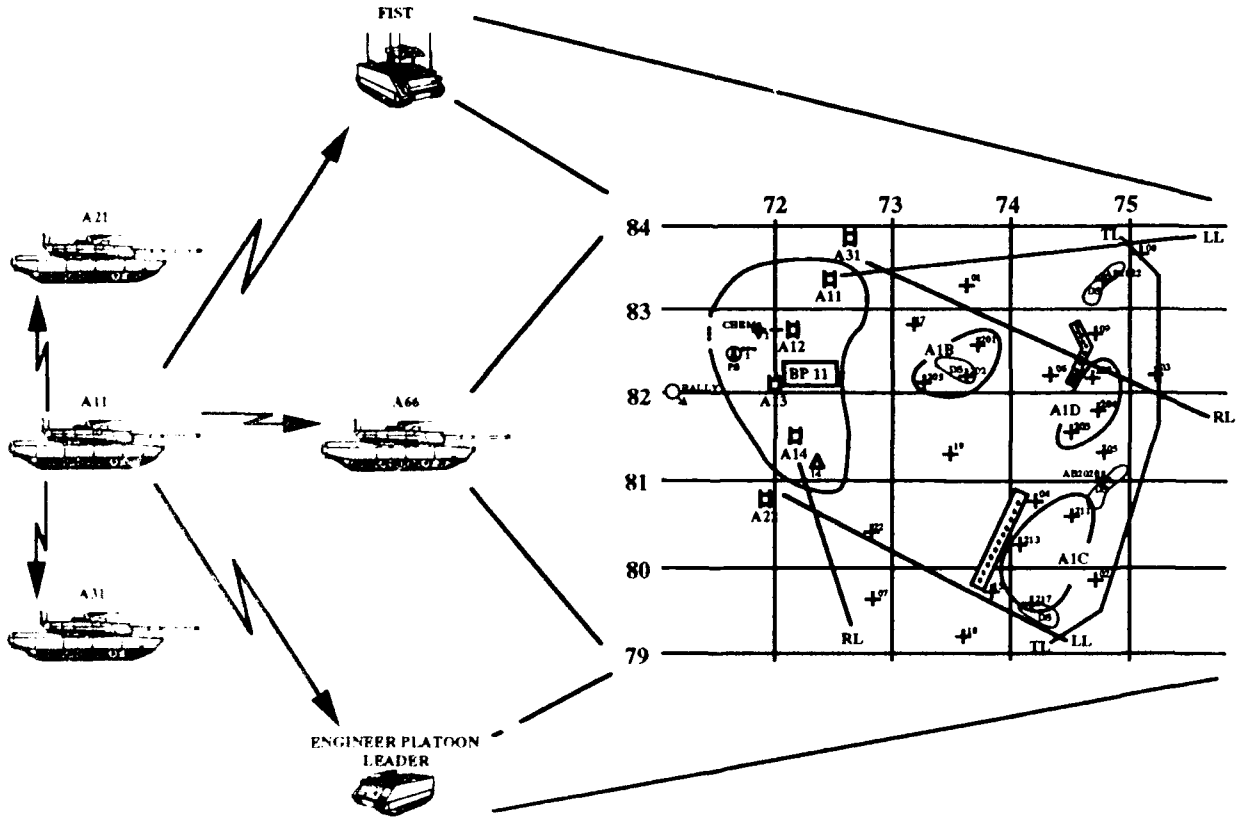


FIGURE 6. Platoon - Pre / Post Combat- Enhanced Mission Support Graphics

- The IVIS capability to easily exchange and develop standard graphics allows the two adjacent units to jointly develop any required control measures during their face-to-face coordination. This capability may contribute to more effectively controlled direct fires, thus reducing the conditions that may lead to an incident of fratricide. Any jointly developed graphics that may have changed the platoon leader's original fire plan can be quickly added, and then retransmitted to the company commander (and others within the company/team) while the platoon leader is enroute back to the company area.

- Any additional changes to the mission graphics that take place as the tactical plan of either unit is refined may be easily transmitted to the adjacent unit without the need for additional face-to-face coordination. This allows each unit to maintain within the IVIS database the most up-to-date version of its adjacent unit's control measures and mission support graphics, thus contributing significantly to the situational awareness of all units on the battlefield.

4. *Platoon - data/information messaging.* The platoon leader and/or platoon sergeant use the IVIS to transmit routine reports at the intervals stated in the unit tactical SOP.

- The platoon leader's IVIS will automatically aggregate the status of his own vehicle's Ammunition Report, POL Report, and Vehicle Status Report with that of the platoon's other vehicles (based on individual reports sent by the platoon sergeant and wingmen). The IVIS will automatically fill in message fields for date/time group, call sign of the sender, and if required, the position location of the platoon leader. The platoon leader reviews the aggregated platoon report(s), and then transmits the report to the company commander, executive officer (XO), and first sergeant (1SG) (Figure 7). The IVIS is also capable of **automatically** displaying to the vehicle commander, and then transmitting, a Request Report for both ammunition and POL when the on-hand quantities for main gun and/or coax machine gun ammunition, or vehicle fuel level fall below 60% of the vehicle's basic load.

- Personnel Reports. The platoon leader/sergeant may use IVIS to manually input and then transmit personnel status in accordance with (IAW) the unit's SOP or as casualties occur. Individual vehicle/crew reports will be aggregated automatically by the IVIS into a consolidated platoon report prior to transmission to the company commander, XO, and 1SG.

5. *Company level.* Effective and efficient use of the IVIS at the company/team level is based on having an "interface" with other non-IVIS command and control systems within the company organization. Mission planning and data/information messaging is effective if automated C2 systems of the members of the company/team have the capability to

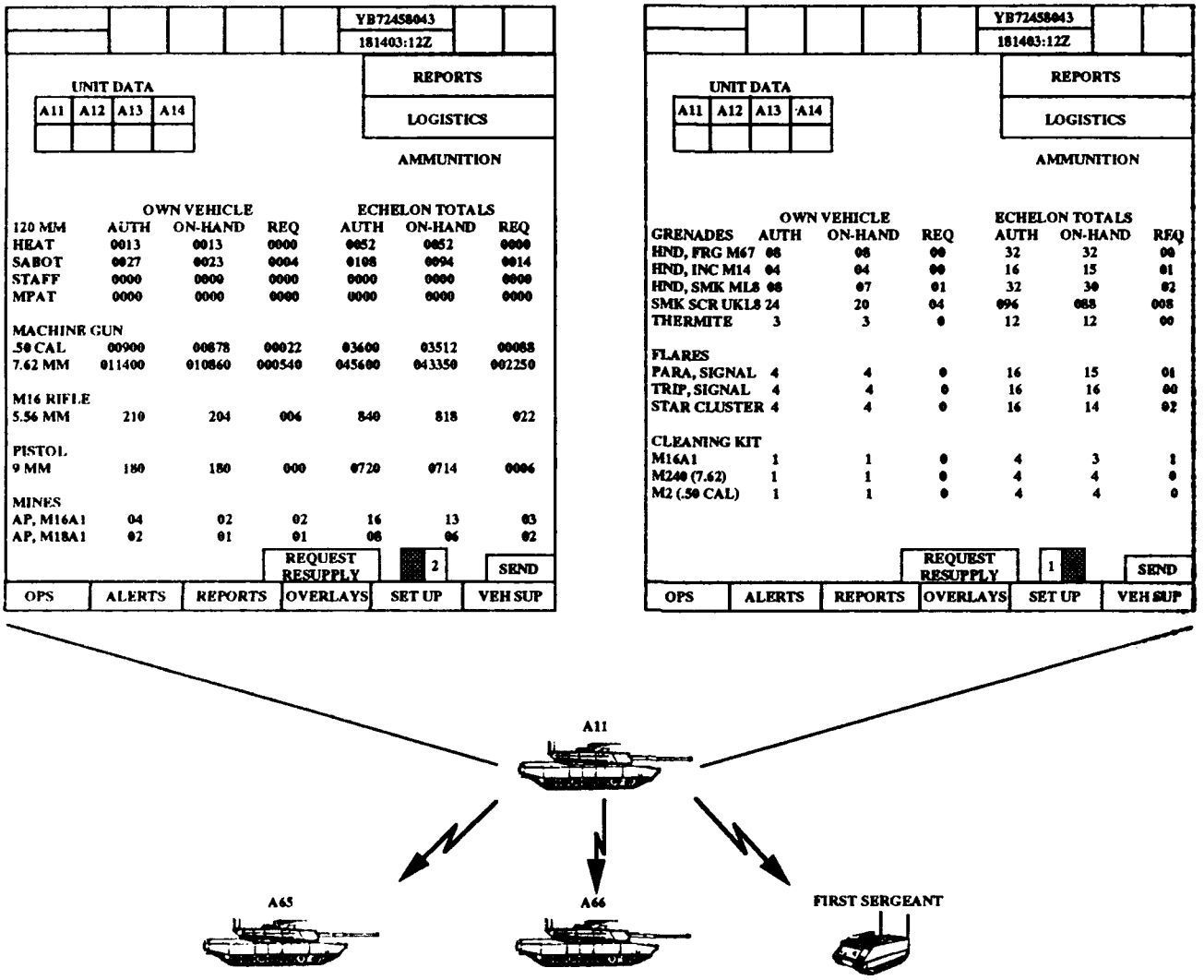


FIGURE 7. Platoon - Pre / Post Combat - Reporting (Class V)

exchange graphics, overlays, and messages. Exchange of mission planning data and messaging does not require **total** exchange of all messages within the IVIS message set, but rather only those messages that are required by each member of the team in order to provide support function for the organization. The traditional relationship of "supporting to supported" requires automated C2 systems of attached elements of the company/team to have the capability to transmit and receive IVIS messages, reports, and overlays.

a. *Company level - mission planning.* The members of the Armor company/team use inter-vehicular transmission of data and graphics to plan, prepare, and coordinate upcoming missions.

- Mission planning by all members of the company/team is initiated upon receipt of the company commander's Warning Order and preliminary operational graphics. Tank platoon leaders, the First Sergeant (controlling the company combat trains), the Fire Support Team (FIST), and any other attached elements (Engineer Platoon/Section, Air Defense Section, etc.) initiate their respective preparations/actions based on the nature of the upcoming offensive or defensive mission (Figure 8).

- Each company/team subordinate and supporting element uses their respective automated C2 system(s) to develop initial supporting graphics (offensive or defensive) based on the commander's preliminary guidance and graphics. The commander uses the IVIS to develop graphics that support his scheme of maneuver and operational concept, and then transmits a maneuver overlay and execution matrix that will enable his subordinates to complete their own supporting graphics.

oo Subordinate tank platoon leaders use IVIS to develop their own maneuver graphics required to support the company concept of the operation. The completed graphic overlay is transmitted back to the company commander for aggregation into the company fire plan/sector sketch or scheme of maneuver. Copies of each platoon's overlay are also sent to the FIST, engineer, and any other supporting element in order to supplement their own mission support planning process.

oo The FIST Team Chief and his subordinates use the commander's initial graphics and the platoon leaders' transmitted graphics to develop the indirect fire support plan and graphics. Once the company fire support graphics are completed, the graphic overlay and fire support matrix is transmitted to the company commander and platoon leaders and leaders of any supporting elements (engineer, ADA). Similarly, the FIST can transmit the company fire support plan to the Fire Support Element at the Battalion TOC for aggregation into the battalion's indirect fire support plan (Figure 9).

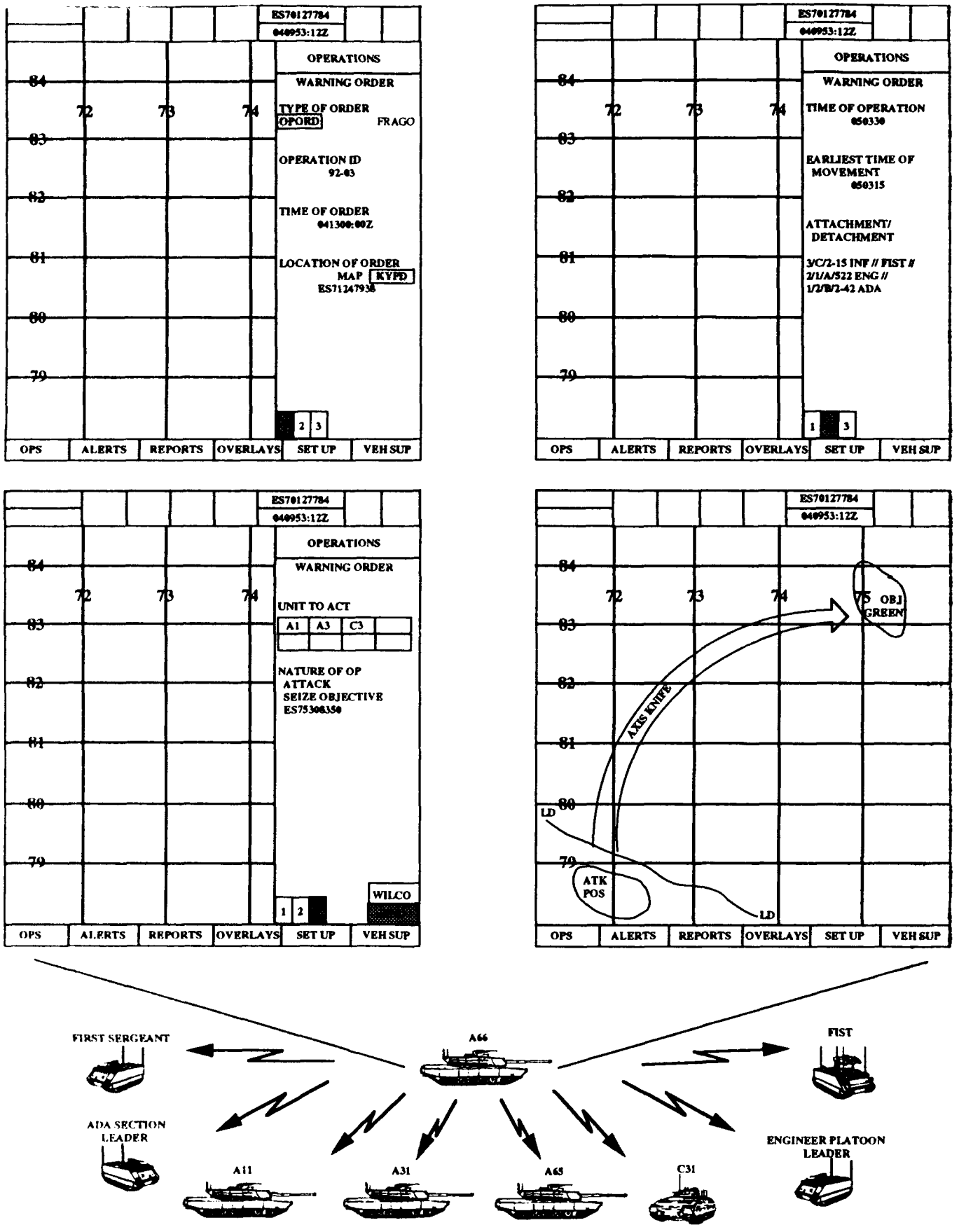


FIGURE 8. Company - Pre / Post Combat - Mission Planning

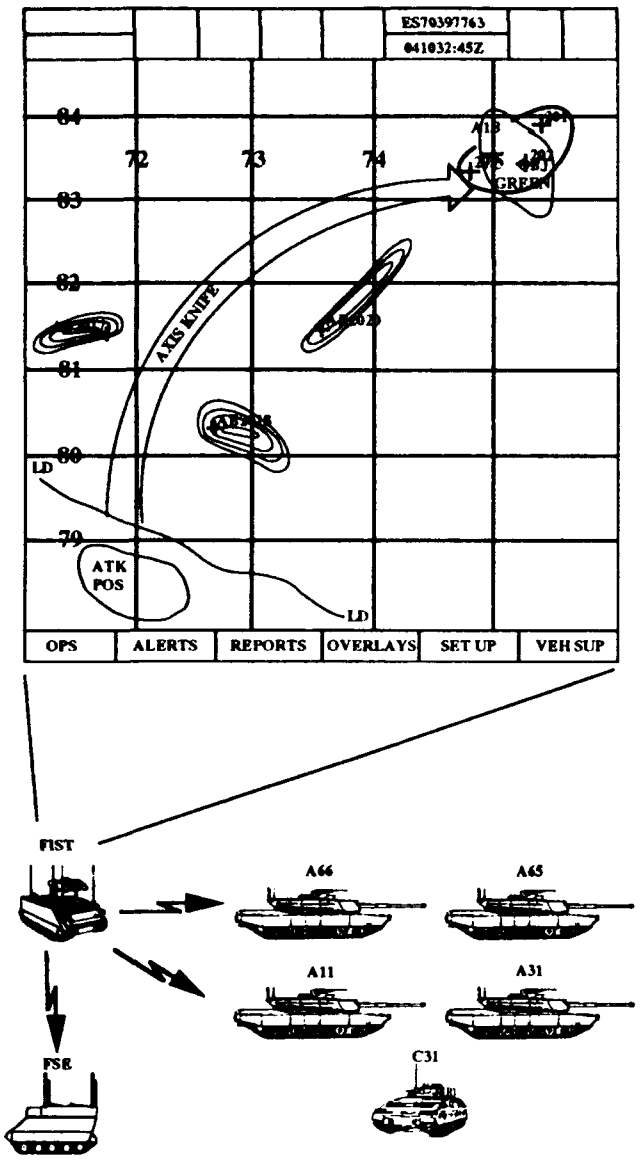


FIGURE 9. Company - Pre / Post Combat - Mission Planning
FIST Fire Support Plan

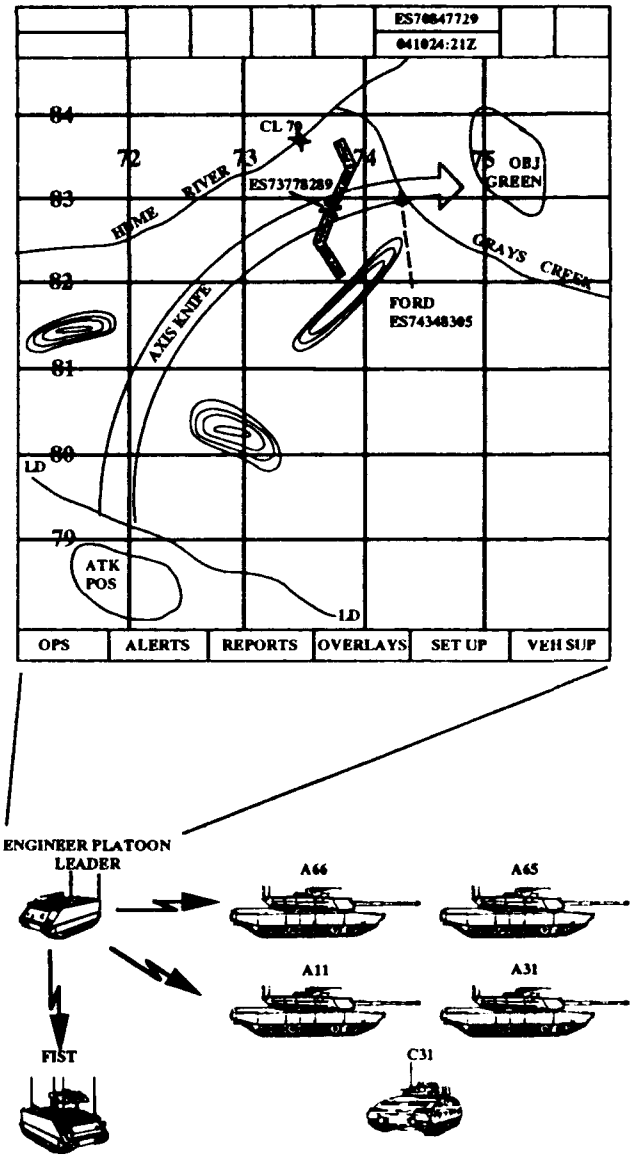


FIGURE 10. Company - Pre / Post Combat - Mission Planning
Engineer Support Plan

oo During defensive missions, the Engineer platoon/section leader begins preparation of obstacles based on initial guidance from the company commander, and in accordance with the Battalion Engineer's obstacle plan. The platoon/section leader transmits reports of completed obstacles to the company commander, FIST, and platoon leaders, along with an obstacle overlay giving the location of each obstacle. Updated versions of the overlay are transmitted as the barriers are emplaced by the engineer platoon/section. Barriers emplaced by combat elements (tank crews and/or infantry) are also added to the company obstacle overlay.

oo For offensive missions, the company maneuver overlay (with supporting graphics) is analyzed by the engineer platoon/section leader for areas that may require mobility support for the company/team movement. Supporting graphics can be added to the company/team maneuver overlay by the engineer platoon/section leader to show possible ford sites, bridge locations (with bridge classification designation), locations of potential obstacles (elevated railroad track beds, narrow underpasses and roads, etc.), and then transmitted to the company commander, platoon leaders, and FIST (Figure 10).

- The First Sergeant and Executive Officer use the commander's initial graphics to plan for locations of the company combat trains, ammunition prestock points, rearm/refuel points, casualty and prisoner of war (POW) collection points, routes of evacuation to the battalion/task force Main Supply Routes (MSRs), and maneuver routes for the trains. This information is then transmitted to the company/team commander for consolidation into the company's final maneuver overlay (Figure 11).

- The company/team commander receives all of the above elements' supporting graphics/overlays through IVIS, and consolidates them into a "complete" company overlay (Figure 12). Each supporting overlay (maneuver, fire support, engineer, and logistics) can be displayed on the Commander's Integrated Display (CID) all at once, or one at a time in order to reduce map display clutter. Each overlay not displayed on the CID is stored in the IVIS database and can be recalled for display, retransmitted to other elements within the task force, or deleted in favor of a more recent overlay.

- Once the commander has received mission graphics and supporting overlays from his subordinates within the company/team, he then retransmits the overlays to the Battalion TOC for aggregation into the battalion graphics and supporting overlays. The ability to transmit this information over the Battalion O&I radio net provides the company/team commander with the **ability to spend more time forward coordinating and supervising the actions and missions of his subordinate elements**, rather than having to deliver a handmade copy of each of the above mentioned graphic overlays to the TOC and Combat

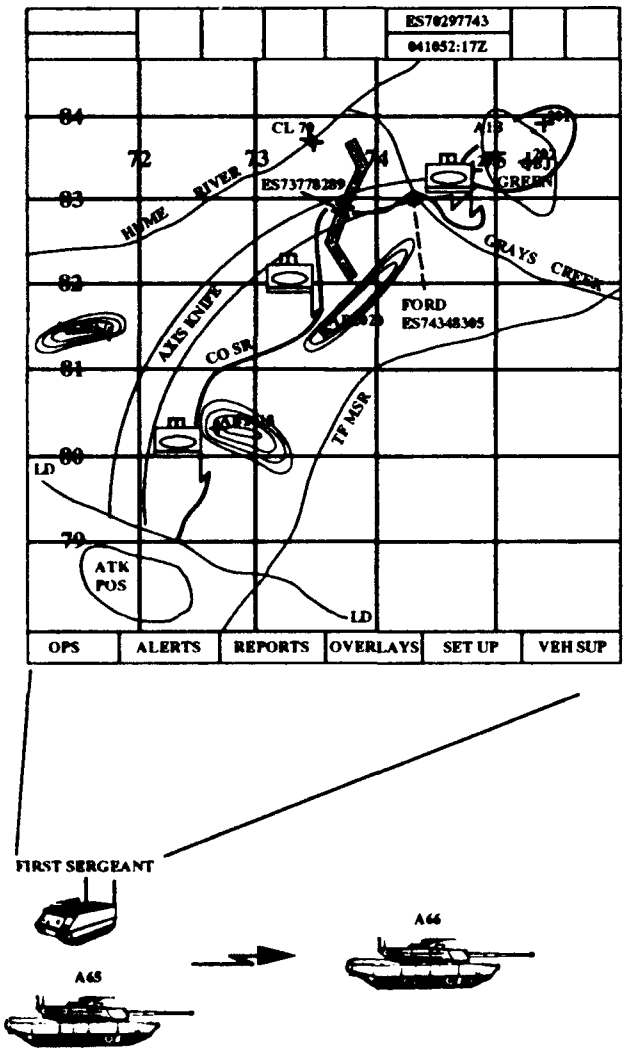


FIGURE 11. Company - Pre / Post Combat - Mission Planning Combat Service Support Plan

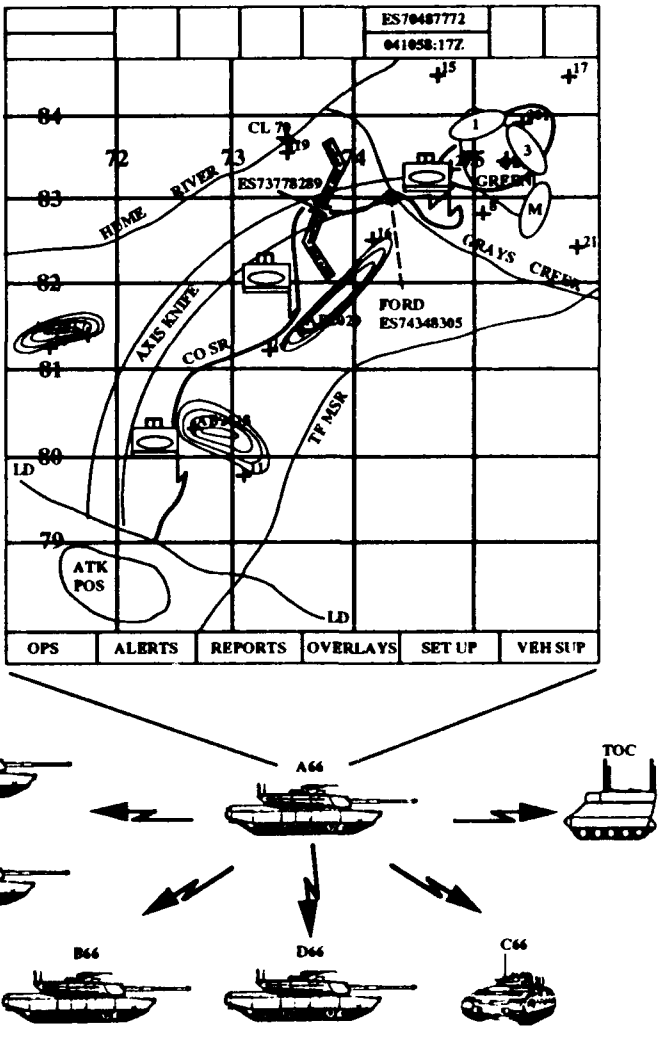


FIGURE 12. Company - Pre / Post Combat - Mission Planning Consolidated Mission Graphics

Trains Command Post (CTCP). Frequency and/or initial transmission of company/team graphics to the TOC is based on mission planning requirements and the unit's tactical SOP.

- Like the TOC, the commander of each company/team also receives the overlays of the other company/teams. This allows each commander to conduct a quick analysis of the maneuver and support plans of each unit within the task force, especially for the purpose of coordinating direct and indirect fires and maneuver with adjacent and/or forward elements. The ability to transmit and receive graphics among the task force major combat elements using the SINCGARS may reduce the need for face-to-face coordination to exchange graphics with potentially two to three other units/elements.

- Each company/team commander can exchange graphics through the IVIS, and retransmit them to their subordinates, thereby improving the situational awareness of platoon and supporting element leaders. Improved understanding among the leadership of the task force of not only their own unit mission and scheme of maneuver, but also of their adjacent units' maneuver, may potentially lead to a reduction in the preconditions that might otherwise lead to an incident of one unit engaging another unit.

b. *Company level - data/information messaging.* The company/team commander, executive officer, and first sergeant use the IVIS to receive and transmit routine reports at the intervals stated in the unit tactical SOP. Platoon reports transmitted using IVIS are consolidated with the reports of supporting elements within the company/team for transmission to the TOC and CTCP. Additionally, the ability of the IVIS to digitally transmit these reports using the SINCGARS reduces the required radio net transmission time, and thus the electronic signature of the unit.

- Administrative and logistics reports within the IVIS message set are sent by subordinate elements within the company/team to the XO and 1SG for consolidation into a company report and then transmitted to the TOC and CTCP. The IVIS within the XO's tank, or the automated C2 system that the 1SG uses, is capable of automatically aggregating the transmitted data of the subordinate and supporting elements. The company/team's supporting elements (FIST, ADA section, engineer platoon/section) transmit administrative and logistic reports IAW the format of the supported unit tactical SOP. Interfaces between the automated C2 systems of each supporting element and IVIS equipped tanks make the transmission and receipt of these messages possible (Figure 13).

- The capability of IVIS to consolidate all of the admin/log data of the company/team significantly reduces the preparation time of these reports, and subsequently speeds up the process of sustaining the company. The XO and/or 1SG

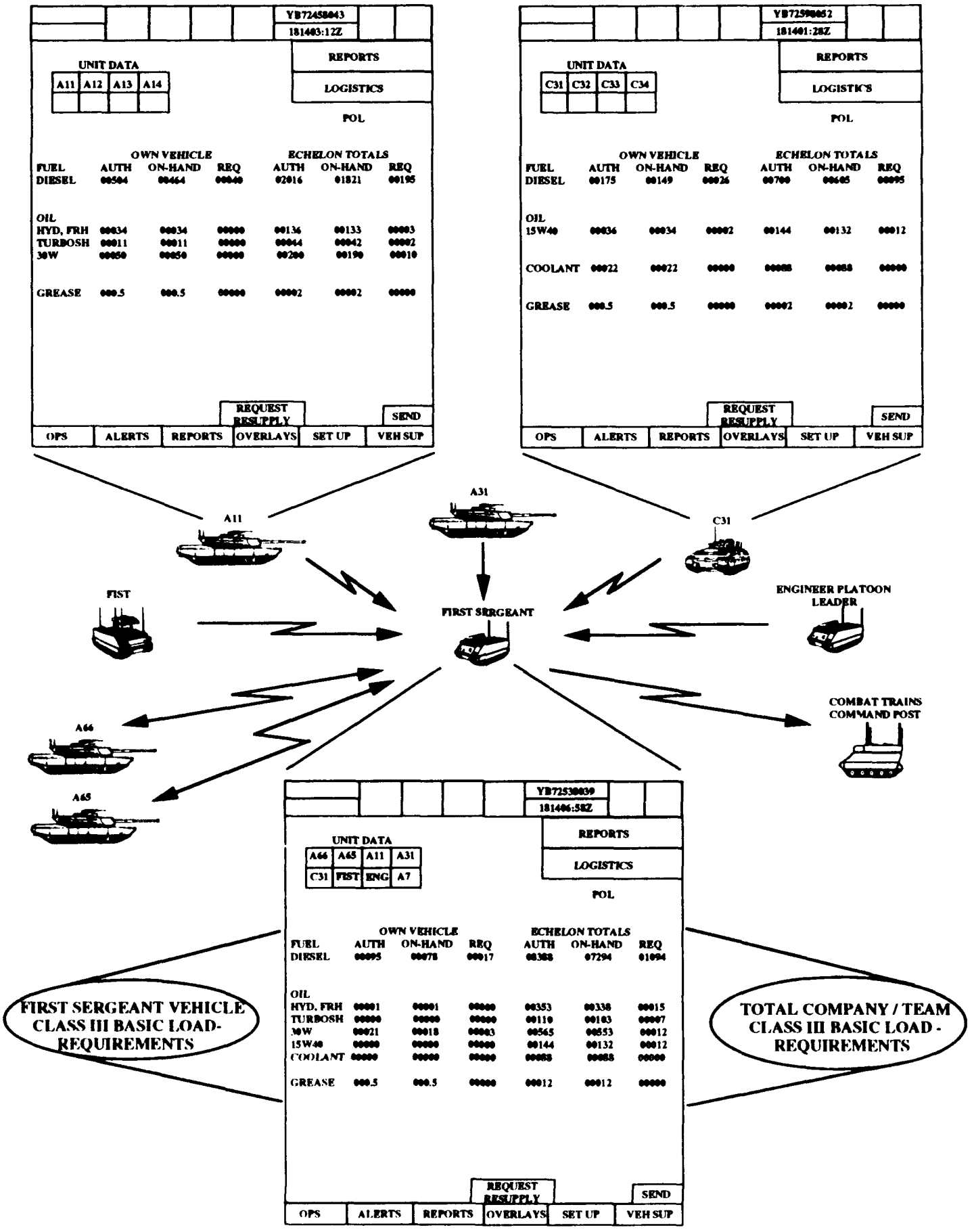


FIGURE 13. Company - Pre / Post Combat - Reporting Consolidated Co / Tm Class III Report

transmit the consolidated reports to the TOC and/or CTCP where they are automatically aggregated into task force level reports and stored in the S-3 and S-4 sections' systems databases for easy retrieval and display of individual unit status. The ability of the IVIS to automatically exchange tactical data with its higher echelon system also speeds up the process of rearming the team through the virtual elimination of the requirement for manual entry of subordinate unit admin/log data into the parent C2 system - a task currently performed by the staff at the battalion level. **Common report formats** within the tank company/team and its supporting elements for these messages is required for the system to adequately speed up this process.

- IVIS Position Update reports of subordinate elements are transmitted over the company command radio net. This allows the commander, XO and 1SG to maintain situational awareness of the location of the unit's forces, and is especially important during the mission preparation phase as each of the platoons conduct rehearsals and/or prepare defensive positions. Movement of assets at night is better monitored and controlled by the unit leadership, reducing the need for frequent voice update of position location and subsequently the length and number of radio transmissions at the company/team level.

6. *Battalion level.* Effective and efficient use of the IVIS at the battalion/task force level is based on having the ability of IVIS to exchange reports, messages, overlays, and orders with other battalion and below command and control systems within the task force. Mission planning and data/ information messaging is only effective if automated C2 systems of the primary commanders and staff of the task force have the capability to exchange graphics, overlays, and messages. Exchange of mission planning data and messaging does not require **total** exchange of all messages IVIS messages, but rather only those messages that allow each member of the task force to perform their respective support function for the unit. The interface between IVIS and its higher echelon system provides an essential link with the task force staff, providing the staff with the ability to receive **tactical reports** from the subordinate companies and speciality platoons of the task force. The staff uses subordinate unit tactical data to develop staff estimates for the commander, and subsequently provide **information** ("processed" data) to the commander.

a. *Battalion level - mission planning.* The task force planning cells (TOC and CTCP) exchange data and information with higher and subordinate elements using their respective C2 system. Communication and system interfaces with counterparts at the Brigade level, using Force Level Control System interfaces with other Army Command and Control System Battlefield Functional Area (BFA) C2 systems (ASAS, AFATDS, FAADC2I, and CSSCS), provides the task force staff with sensor and intelligence data from sources well above the task force

(and even brigade) level. Unit status reports and reports from leaders' reconnaissance also provide the task force staff with data that is essential to the staff planning process.

- The staff's mission planning begins with the receipt of the Warning Order (WO) and preliminary operational graphics from the Brigade TOC (Figure 14). Each of these items is received using the organic communications systems of the task force (Combat Net Radio and/or Mobile Subscriber Equipment) and displayed on the terminals at the TOC and CTCP. The staff uses the initial operational graphics from brigade to develop a task force WO, and enough graphics to allow subordinate elements to begin their own mission planning and leaders reconnaissance. The WO (in execution matrix format found in FM 71-2, Appendix B) and initial task force graphics are transmitted to subordinates using the TOC to IVIS system interface (Figures 15 and 16). The ability to transmit the WO and graphics using SINCGARS to the company/teams and speciality platoons provides a considerably quicker and more efficient means of initiating task force preparation for combat than current *manual* methods, or using automated C2 systems that have no built-in system interface with each other.

oo Each unit commander (company/team and speciality platoon leader) receives the overlay and preliminary execution matrix through the IVIS and can display it on their respective tactical display. This allows all members of the task force leadership to quickly initiate mission planning. The staff will still be required to make multiple "hard" copies of orders and acetate overlays, for their own purposes within their respective command posts as well as a means of providing manual back-up to "IVIS like" systems in combat vehicles.

oo Because the WO matrix and associated overlay can be transmitted from the TOC to IVIS (SINCGARS is the transmission medium), task force subordinate elements need not come the to TOC or collectively gather at a forward point on the battlefield in order to receive initial planning guidance. This capability allows subordinate commanders to **spend more time forward** within the area of operations, giving them additional **time** to perform critical leader tasks: providing orders and directives; performing leaders' reconnaissance; and supervising pre-combat checks.

oo Providing the WO and graphics by digital transmission using the SINCGARS reduces the amount of radio network traffic previously associated with transmission of each by voice. This capability contributes significantly to reducing the electronic signature of the task force TOC.

- The interface between IVIS and its parent C2 system also provides task force subordinate elements with the capability to easily **update the initial graphics** sent by the TOC based on the results of the leaders' reconnaissance.

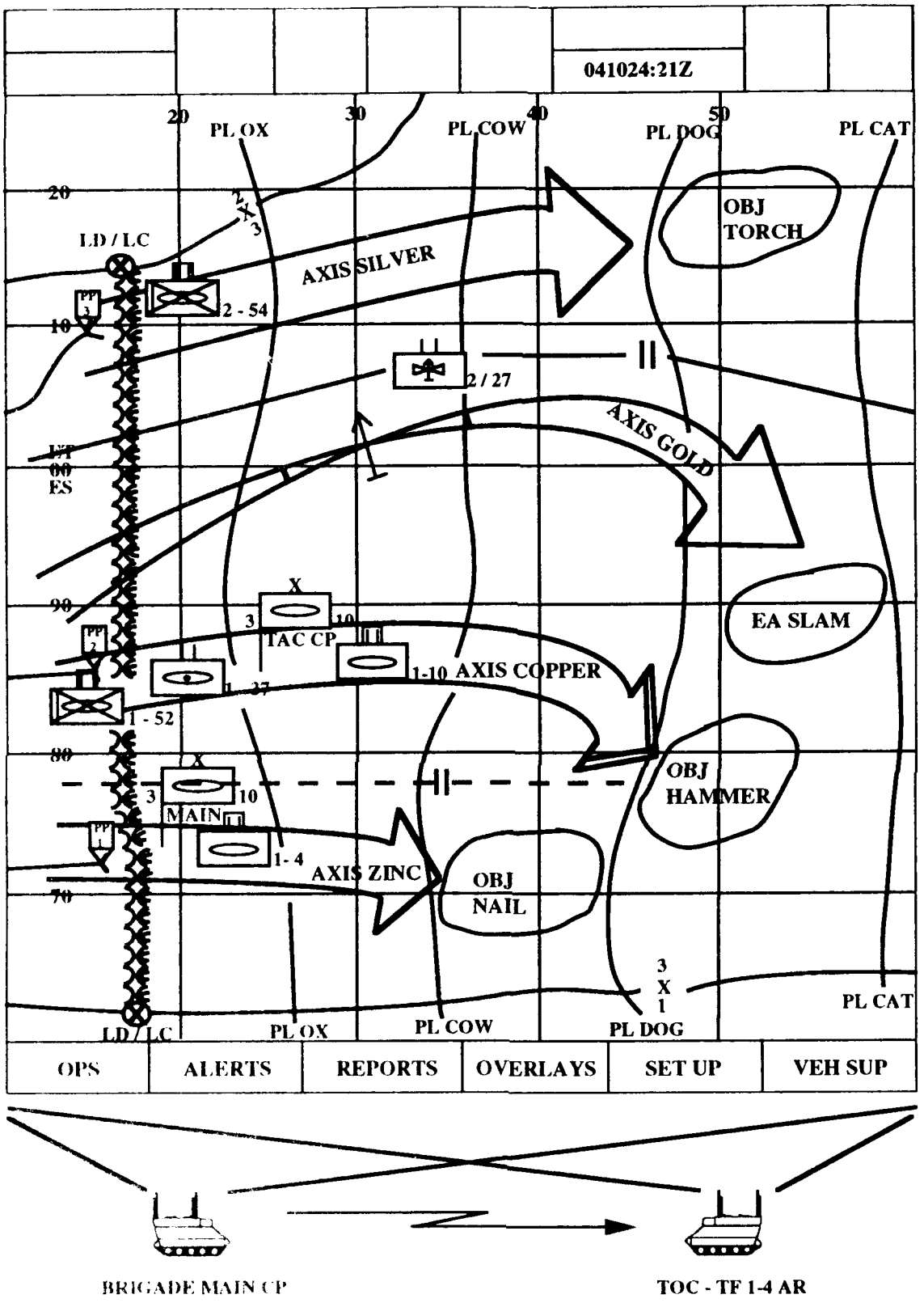


FIGURE 14 Brigade Warning Order - Preliminary Operational Graphics

					ES70840177		
					041041:27Z		

TF 1 - 4 ARMOR OFFENSIVE MATRIX WARNING ORDER # 2 - 98 DTG 041041:27Z

TASK ORG	CO A	TM C	TM MECH	CO D	SCT	ENG	MORT
	1 2 3 2/3/72 1	1 2 3/C/1-52 2	1 2 3/C/1-4 3	1 2 3 4	1 2 3/3/72	1 3/72	RED 3 FDC BLUE 3 FDC 5

TF MISSION: TF 1-4 ATKS 060330Z JUL 92 ALONG AXIS ZINC TO SEIZE OBJ NAIL
CDRS INTENT: RAPIDLY SEIZE OBJ NAIL WHICH PROTECTS BDE'S SOUTHERN FLANK AND BDE MAIN ATK ON AXIS COPPER. ONCE ON NAIL, BE PREPARED O/O TO CONTINUE ATK EAST

LD AA - LD MARCH ORDER	060330 2	4	6	7	EFF IMMED RECON FWD LD 1	3	5
AXIS ZINC	LEAD	SOUTH FLNK	NORTH FLNK	REAR (RESV)	RECON NAIL PL DOG WHEN CO A RPTS PL OX	REDUCE OBST O/O	SMOKE O/O A CO
OBJ NAIL	OBJ N-A	OBJ N-C	OBJ N-M	RESV CATK O/O	SCREEN PL CAT		
FIRES:							
CDR	S3	MAIN CP	CBT TNS	UMCP	FLD TNS	LRP A	LRP B
ADA	MOPP	OEG	SOI	PYRO	AJ CODE	PIR	STAND TO

OPS	ALERTS	REPORTS	OVERLAYS	SET UP	VEH SUP

FIGURE 15. Task Force Warning Order - Warning Order Matrix

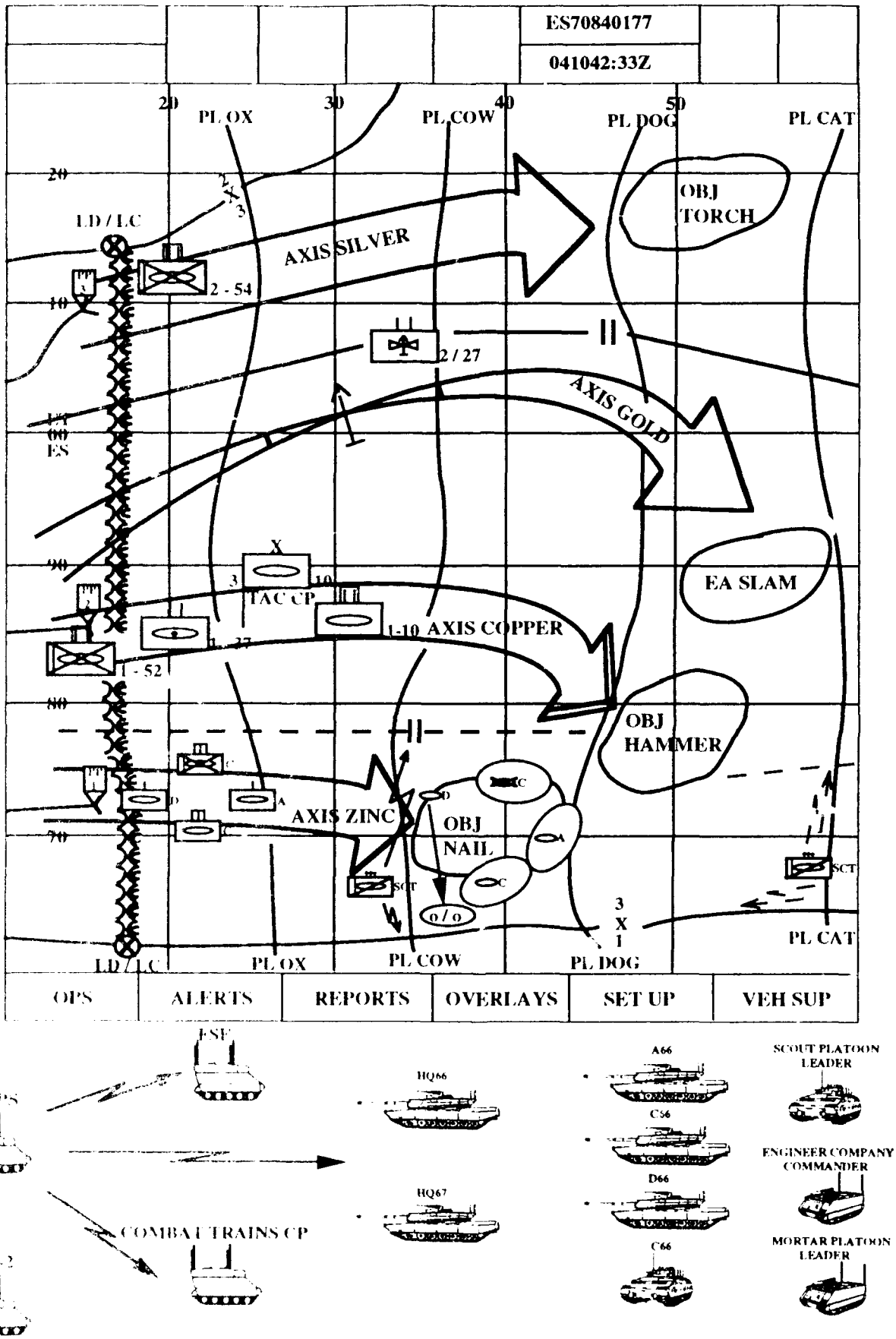


FIGURE 16. Task Force Warning Order - Preliminary Operational Graphics

Subordinate commanders can develop and transmit graphic overlay "updates" to the TOC in order to provide elements of data to the staff that are essential in their mission planning estimates. This capability is especially helpful to the S-2 as he develops his terrain analysis and Intelligence Preparation of the Battlefield (IPB).

- The staff uses the updated graphics transmitted by task force subordinates to refine the operational plan and intelligence, maneuver, fire support, and combat service support overlays. The ability of the staff and subordinate commanders to exchange graphic overlays significantly reduces the amount of voice radio transmission on the task force radio nets during the mission planning phase. It also provides a **synergistic effect** between the TOC and subordinate task force elements that either did not exist before, or was extremely difficult to achieve.

- The TOC to IVIS interface also provides the staff with the capability to transmit the mission OPORD and overlays to the company/teams and specialty platoons. In a well trained organization this provides elements that have time critical missions (e.g., scouts) with a means of receiving the final operational plan without having to be in the task force Assembly Area or immediate area of operations. It also allows members of the task force orders group to receive and study the task force execution matrices (maneuver, fire support, obstacle, etc.) and overlays prior to arriving at the site of the OPORD.

- The TOC to IVIS interface potentially provides for less time consuming orders briefings, better informed leaders at the briefing, and the ability to quickly make changes to everyone's graphics based on discussion at the briefing (changes made on the TOC C2 system workstations and transmitted to IVIS). Shorter mission briefings give time back to the commanders and staff so that they may conduct rehearsals, briefbacks, and spend more time supervising their own subordinates as they prepare for combat.

- The capability to transmit the task force OPORD, execution matrices, and overlays is not intended to eliminate the need for a formal orders brief by the staff. Transmitting orders and matrices via the IVIS provides the commander with the *option* to distribute the order without convening the orders group. However, commanders should always strive to give their operational intent face-to-face with their subordinates. Similarly, the orders brief should be given orally in order to stimulate and encourage discussion among the commanders and with the staff. Bringing the commanders together within an orders group provides the commander with an opportunity to have his subordinates "briefback" their understanding of their

respective mission and the overall task force mission. It is only when time to perform the mission is critically short that the commander should decide not to convene the orders group for an OPORD briefing.

- The interface between IVIS and its parent maneuver C2 system enables subordinate elements to quickly provide their evolving scheme of maneuver to the TOC. This is done using graphic overlays developed by the company/team commanders and other task force elements (scouts, mortars, GSRs, etc.). The overlays are then transmitted to the TOC over SINCGARS where they can be displayed on the S-2 and S-3 C2 system display screens. Subordinate element plans (such as company/team fire plans and sector sketches) can be consolidated into one overlay, and if required, retransmitted to higher headquarters. The staff can use these overlays to ensure that the task force subordinate elements' schemes of maneuver and fires are well coordinated, and that they follow the task force operational plan. The capability to easily receive and display the plans of the task force subordinate elements equates to a better coordinated and controlled organization.

b. *Battalion level - data/information messaging.*

- While it is recognized that the series of U.S. Message Text Format (USMTF) messages provide the staff with data and information necessary for the performance of their *staff functions*, these messages and displays are not well designed for use by combat vehicle crewmen and small unit leaders. The messages within the IVIS message set are based on the message sets found within U.S. Army Armor Center published tactical SOPs for the platoon, company/team, and combined arms task force. Additionally, the IVIS messages are streamlined to suit the battlefield conditions that the combat vehicle and unit commander must sometimes operate under - high tempo conditions, frequently in contact with the enemy.

- The IVIS message set must be well balanced; that is, it must be easy to use and not require much of the vehicle commander's time to input data into the IVIS, but must also have enough data so that sufficient *detail* is provided to the task force staff and the company/team supporting elements. To make the most of the capabilities of an integrated and automated C2 system within the task force, the IVIS message set data fields of certain messages must be capable of "feeding" directly into the data fields of their C2 system at the TOC and CTCP.

- While this is possible for some messages (especially admin/log messages and graphics), it is impossible for others, and in these instances it is necessary for the IVIS message(s) to be added/included in the TOC system's C2 message set.

- An effective link between the IVIS equipped commander and the TOC is based on how efficient each of their respective C2 systems are in automatically reporting and displaying information. With this in mind, it is essential that each of their systems be capable of understanding the data of the other system's message set, transparent to the user, and that the display of that data be in a form that is most useful to the particular user.

- For crewmen of combat vehicles the display of data, tactical or otherwise, should make maximum use of symbology to convey a "picture" that is easy for the commander to understand. The limited time that a combat crewman has to "process" data displayed on the Commander' Integrated Display mandates the use of frequently used, and easily recognized tactical symbols, matrices, or graphs. In the event that preformatted messages must be displayed to convey data to the combat vehicle commander, the format must be simple to understand or work with, and the message must be as short as possible.

- The IVIS messages that feed admin/log data into the CTCP will generally be longer than other IVIS tactical messages due to the requirement to provide the staff with sufficient detailed data. Crew use of admin/log messages is predicated on having the time to manually input the data that the 1SG must provide to the CTCP, or on the degree that the IVIS can automatically develop and transmit the message. The ideal solution is a system that can not only automatically fill in the message for the vehicle commander, but also transmit it based on time parameters established by the unit tactical SOP (i.e., at certain times throughout the day), upon receipt of a "message" requesting a particular report, or as on-board basic load quantities decrease below predetermined levels (Figure 17). IVIS reports for Class III and V will include all basic load items of combat, combat support, and combat service support vehicles respectively. The IVIS will "tailor" reports to list only the Class III and V items that are appropriate to a particular vehicles basic load, yet will also consolidate and display the status of the entire unit's Class III and V on-hand basic load items (previously depicted in Figure 13).

7. *Summary - pre/post combat.* The conditions of the pre/post combat phases typically are such that the individual **vehicle or unit commander has sufficient time** to manually enter into the IVIS admin/log reports the degree of detail that both the 1SG and the CTCP require for eventual entry into the battalion's automated C2. Reports are sent IAW the unit tactical SOP. The staff in the CTCP receives the reports from unit 1SGs through an "interface" between IVIS and its parent C2 system, the IVIS data typically being "translated" into the message format of the parent system, stored in the S-4's system database, and displayed in the format of the staff's C2 system. Storing the data in the format of the higher level system

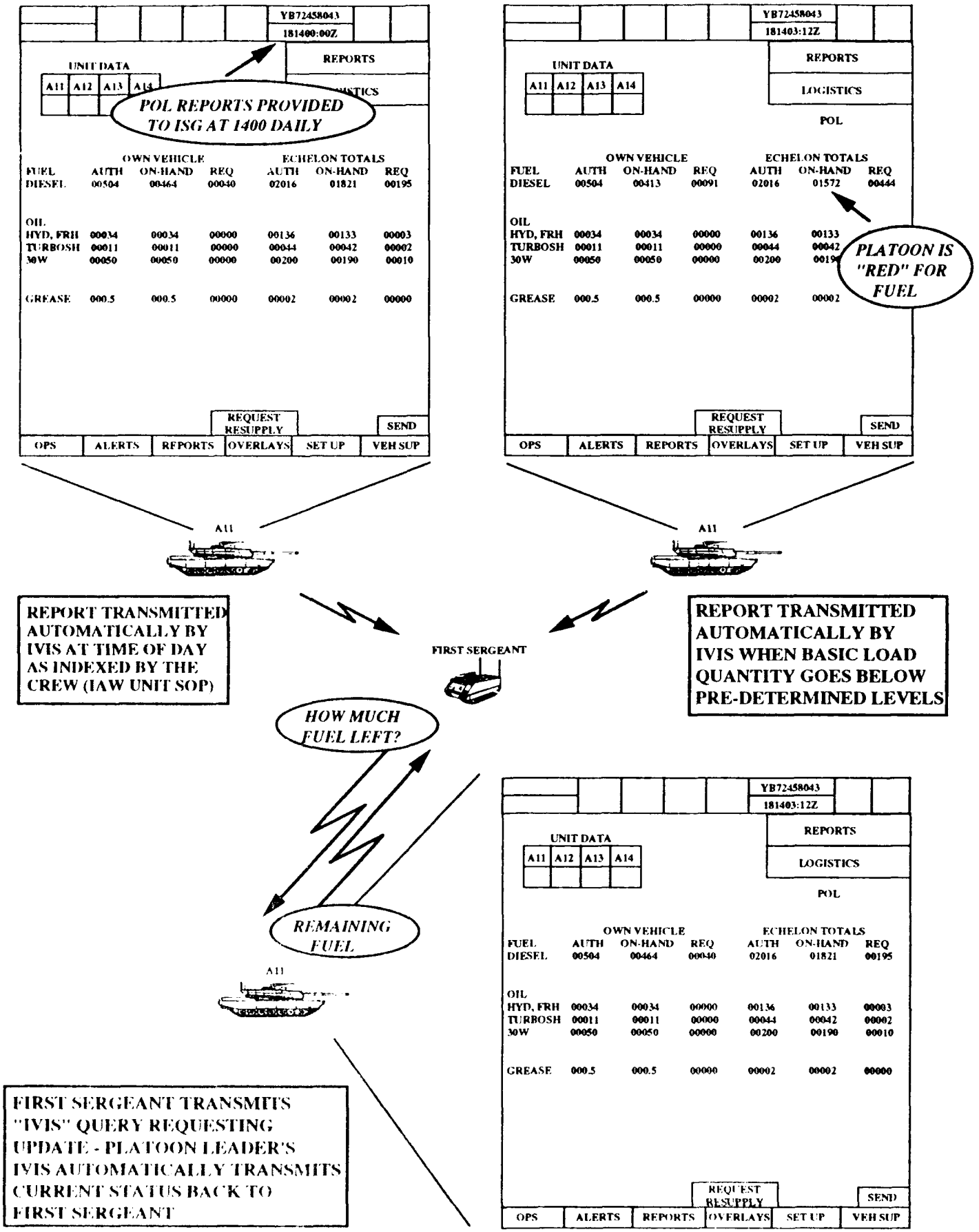


FIGURE 17. Examples of Transmission of IVIS Message

allows the S-4 and S-1 to consolidate task force admin/log data in the format that they must use in order to transmit their own reports to higher headquarters.

a. IVIS preformatted tactical reports are used almost exclusively in lieu of FM voice reporting during the pre/post combat phase, again based on the level of enemy contact or time available to manually input the data into the IVIS. Scouts, company 1SGs and XOs, company commanders, and other specialty platoon leaders use the IVIS to provide the staff with data needed to confirm staff estimates, IPB, and other on demand requests for data. Again, the use of the IVIS messaging capabilities are based on the time available to the crew/leadership to manually input the data into the IVIS and then transmit it to the TOC/CTCP.

b. Near exclusive use of the IVIS messages significantly reduces the electronic signature of the task force during the pre/post combat phases. Reduction of voice messages is possible due to the data requirements of the staff during these phases (heavy on the admin/log reports, fewer requirements for enemy situational data), and the adequate time available for combat crewmen to manually enter data into the IVIS.

c. IVIS type messages from the TOC to the subordinate elements of the task force consists of either limited, individual reports from high level sensor data (that has been transmitted from Brigade and/or other sources), or graphic overlays. Individual reports sent from the TOC to the task force commander and S-3 (if they are forward in their tanks), or to the company/team and specialty platoon leaders, are transmitted in either IVIS message format (usually a SPOT report or Obstacle Report), or in the form of a graphic overlay that the recipient can display on his CID. The overlay is preferred over that of the individual report because it is the result of *analysis* by the staff of typically many reports potentially provided by many sources, and therefore requires less interpretation by the receiving commander.

E. *Combat.*

1. *General.* The use of the IVIS begins to change significantly as the task force elements begin to transition from the pre-combat, or mission preparation phase, to the mission execution phase of the operation. The primary reason for the transition is the **change in focus of the combat elements.**

a. As the task force draws nearer to the enemy, the focus of the combat and combat support elements shifts to the area in which they can employ their direct or indirect fire weapon systems. Even though the staff continues to provide the task force and company/team commanders with the picture of the

tactical situation well beyond the task force area of interest (through sensor input from elements at levels brigade and above), the area of interest of the majority of the weapon systems (which are also the primary source of near-in tactical data) is chiefly the area in which they can observe through their direct view optics. This will have an impact on way in which tactical data is forwarded up through the structure of automated tactical C2 systems within the task force organization.

b. The development and transmission of graphics using IVIS, and its interface with the battalion and other level automated C2 systems within the task force continues to provide a significant enhancement to the current method of updating the commander with a picture of the battlefield situation. The development of graphics by the vehicle and unit commanders within the company/team drops off significantly from that of the pre-combat phase. The staff, however, continues to develop graphic overlays on its system that provide the commander and his subordinate commanders with an easy to interpret picture of the tactical situation. The TOC to IVIS interface provides the means of transmitting the staff developed graphics to the commander in his tank.

c. Graphics developed at the TOC and transmitted to the commander, S-3, and subordinate commanders also provide the task force with the capability to quickly and effectively change unit missions. This capability is especially effective for units on the move, and does not require the assembly of the task force orders group in order to provide graphics and/or a Fragmentary Order (FRAGO) execution matrix.

2. *Individual vehicle - data/information messaging.*

a. As the combat elements of the task force make contact with the enemy, the use of IVIS by individual combat vehicle crews to develop and transmit tactical messages (SPOT Report, Obstacle Report, etc.) drops off significantly. This is primarily due to the need for a certain degree of human interaction with the system in order to input data into the preformatted reports. The requirement for human interaction with the IVIS conflicts with the need for the combat vehicle commander to also fight his weapon system. In the case where the enemy has been joined, the attention of the combat vehicle commander is on what he can see through his sights.

b. The information on the vehicle commander's CID provides enhanced situational awareness through mutual position location of IVIS equipped combat elements, operational graphic overlays with the unit's control measures, and enemy and friendly situational update overlays provided by the staff.

c. Tactical reports are provided by the individual vehicle commander to the extent that the IVIS can automatically fill in portions of the message, thereby reducing crew workload and interaction required with the system. The vehicle commander uses manually developed reports only when he has sufficient time to input data into the report. When contact is made with the enemy, it is expected that most combat vehicle commanders will use IVIS primarily to supplement situational awareness and vehicle maneuver, and report the tactical situation through FM voice transmissions.

d. Admin/log reports for fuel and ammunition will be transmitted automatically by the IVIS. The amount of report data *automatically* provided by the IVIS is based on the integration of sensors into the vehicle that are capable of monitoring ammunition and fuel expenditure. Those items within the report that are not tied to an on-board sensor are not reported (Figure 18 - see Figure 7 for comparison). This shortcoming, however, is not critical due to the fact that the primary resources essential to continued combat effectiveness of the vehicle are fuel and main gun ammunition - items that are monitored by the IVIS. The vehicle admin/log reports are sent to the platoon leader and platoon sergeant for aggregation into a platoon report.

e. Position Update reports are sent automatically by the IVIS. This capability allows each vehicle within the platoon to have the location of other vehicles within the platoon. Ideally, it is possible for each vehicle to have the location of all IVIS equipped vehicles within the task force. The ability to aggregate these vehicles into representative tactical unit symbols is essential for the "decluttering" of the CID. Aggregation of individual vehicle icons displayed on the CID could be based on the vehicle commander's preference in order to maintain his desired level of situational awareness. The vehicle commander could chose to aggregate vehicles within the same organization at either the platoon, company, and task force levels (Figure 19).

3. *Individual vehicle - IVIS graphics.* The use of IVIS graphics by the combat vehicle commander during the execution of the mission will be very limited (primarily due to the time required to develop the graphics). Mission graphics displayed on the CID will be limited to only those required by the vehicle commander to execute his maneuver (pre-planned routes, location of obstacles) and fires (direct fire plans and sector sketches; indirect fires overlay). Enemy situational update overlays transmitted by the company/team leadership (from the S-2) may also be displayed.

4. *Platoon - data/information messaging.*

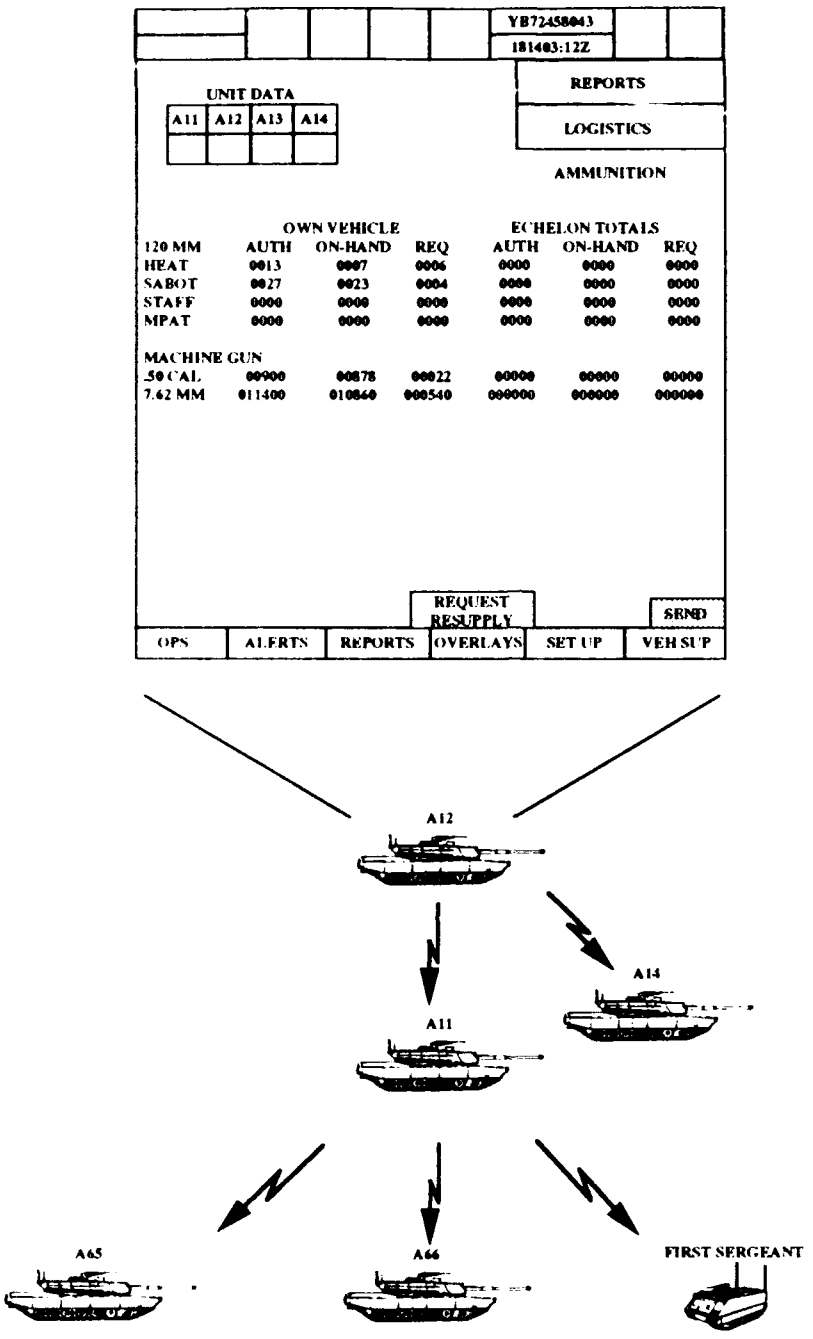


FIGURE 18. Wingman's Class V Report - Combat Mode

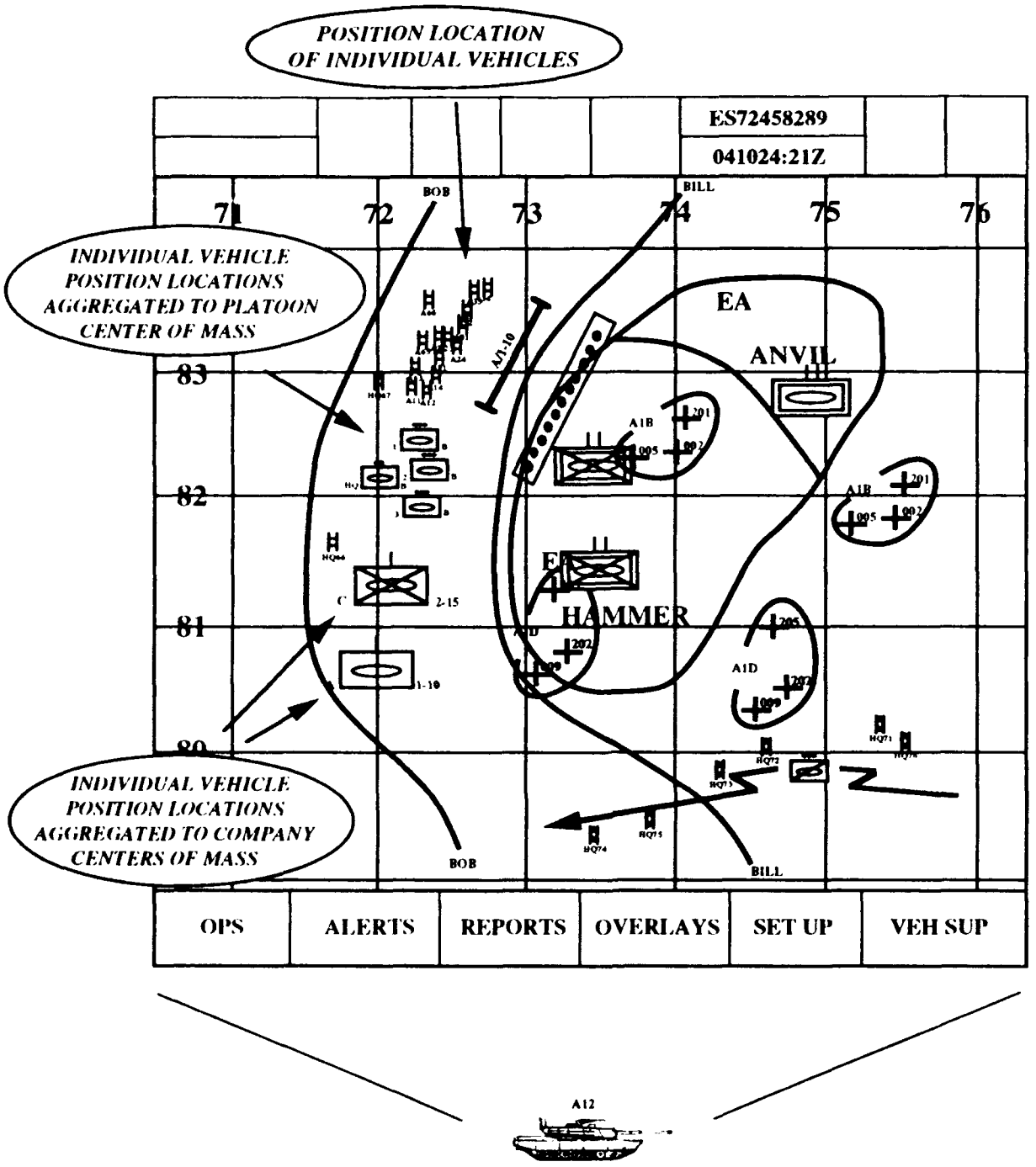


FIGURE 19. Wingman's Potential Situational Awareness Via IVIS Position Updates - Combat Mode

a. The platoon leader and platoon sergeant face the same limitations (time and enemy situation) as the individual combat vehicle commander with respect to IVIS tactical reporting. Digital messages transmitted by the individual vehicles within the platoon are easily retransmitted to the company commander and others on the company command net. The platoon leader's use of IVIS messages for reporting the tactical situation and the admin/log status of the platoon is similar in concept to the individual vehicle commander. The platoon leader must rely on the automated capabilities of the IVIS to the maximum degree possible for message generation and transmission.

b. Admin/log reports from each subordinate vehicle are consolidated automatically by the IVIS and transmitted to the 1SG based on time of day established by the unit tactical SOP, expended fuel or ammunition, or a "system query" (one C2 system automatically interrcgating another) by the 1SG.

c. Tactical situation reports (SPOT Report, Obstacle Report, Contact Report, NBC Reports, and SHELLREP) are transmitted using IVIS preformatted reports, time permitting, or by FM voice radio transmission. Reports transmitted using IVIS are sent to the company leadership (CO, XO, and 1SG) and the supporting elements of the company/team (FIST, Engineer Platoon/Section Leader, ADA Section Leader, etc.).

d. Some tactical reports are sent by FM voice due to the urgency of the situation, then followed-up by a IVIS report as time permits. Examples of this include the Contact Report - transmitted by voice by the platoon leader of platoon sergeant to ensure that all elements of the company/team are alerted of the enemy contact; and, the MOPP Alert, NBC Alert, and Air Alert - all three used to notify company/team elements of the requirement for immediate action. Sending these reports by FM voice or IVIS is, of course, situationally dependent on the level of enemy contact that the unit is experiencing. Even though the IVIS can provide a visual and audible cue signifying the receipt of a Flash or Immediate message, the enemy or tactical situation may mandate the use of FM voice over that of the IVIS for transmission of any of the above messages.

e. Position Update messages are transmitted automatically by the IVIS to other company/team elements by way of the company command net.

5. *Platoon - IVIS graphics.* The platoon leader and platoon sergeant use the CID to display mission support graphics ranging from enemy and friendly situational overlays, obstacle and fire support overlays, and maneuver oriented control measures. Changes to graphics displayed on the CID are

based on time available to alter existing overlays, or create a new overlay for transmission. Again, the ability to develop or change graphic overlays is based on the time available to do so and the enemy situation.

a. Enemy overlay updates developed by the task force S-2 and retransmitted by the company commander can be quickly displayed by the platoon elements (Figure 20). These overlays can be quickly "removed" and replaced by other more recent updates.

6. *Company level - data/information messaging.* The company/team level is the first command and control echelon where elements from other BFAs are attached or OPCON to an Armor organization. While the *functions* that each supporting element (FIST, Engineer, ADA, Aviation) performs for the company/team may differ, the tactical data and information that each element requires to execute their support tasks is similar.

a. The FIST currently receives situational data by eavesdropping on the company/team command net. Spot Reports (SPOTREPs) and Contact Reports transmitted by the platoons provide the FIST with the data necessary to support the company/team with indirect fires. Ideally, the FIST is pro-active and will develop fire missions based on targets of opportunity reported by the platoons.

- The data required by the FIST to request a fire mission is provided by reports such as the SPOTREP. Without an IVIS to AFATDS system interface, the FIST would have no possible means of receiving the IVIS report data that he relies on in order to be pro-active. Conversely, the IVIS - AFATDS interface has the capability to significantly reduce the manual input of the data into the AFATDS messages. This capability is possible by ensuring that IVIS and AFATDS messages have similar data fields and data items. Conceptually this would allow data fields from a IVIS message to be directly and automatically inserted into an AFATDS Call for Fire message, and thus reduce the time required by the FIST to develop messages requesting indirect fires (Figure 21).

b. The FIST, engineer, and ADA leader must all be able to receive IVIS messages and alerts that are transmitted using the IVIS so that they may take immediate action (change MOPP status, prepare for Air Alert, etc.), or support the company/team with indirect fires, engineer support, or ADA coverage. IVIS messages that report the tactical situation must be received by each of the above supporting elements if they are to maintain situational awareness of the company/team and task force missions. This requirement is especially true of the FIST and its ability to receive Position Update messages, especially of elements out of direct viewing range (Scouts).

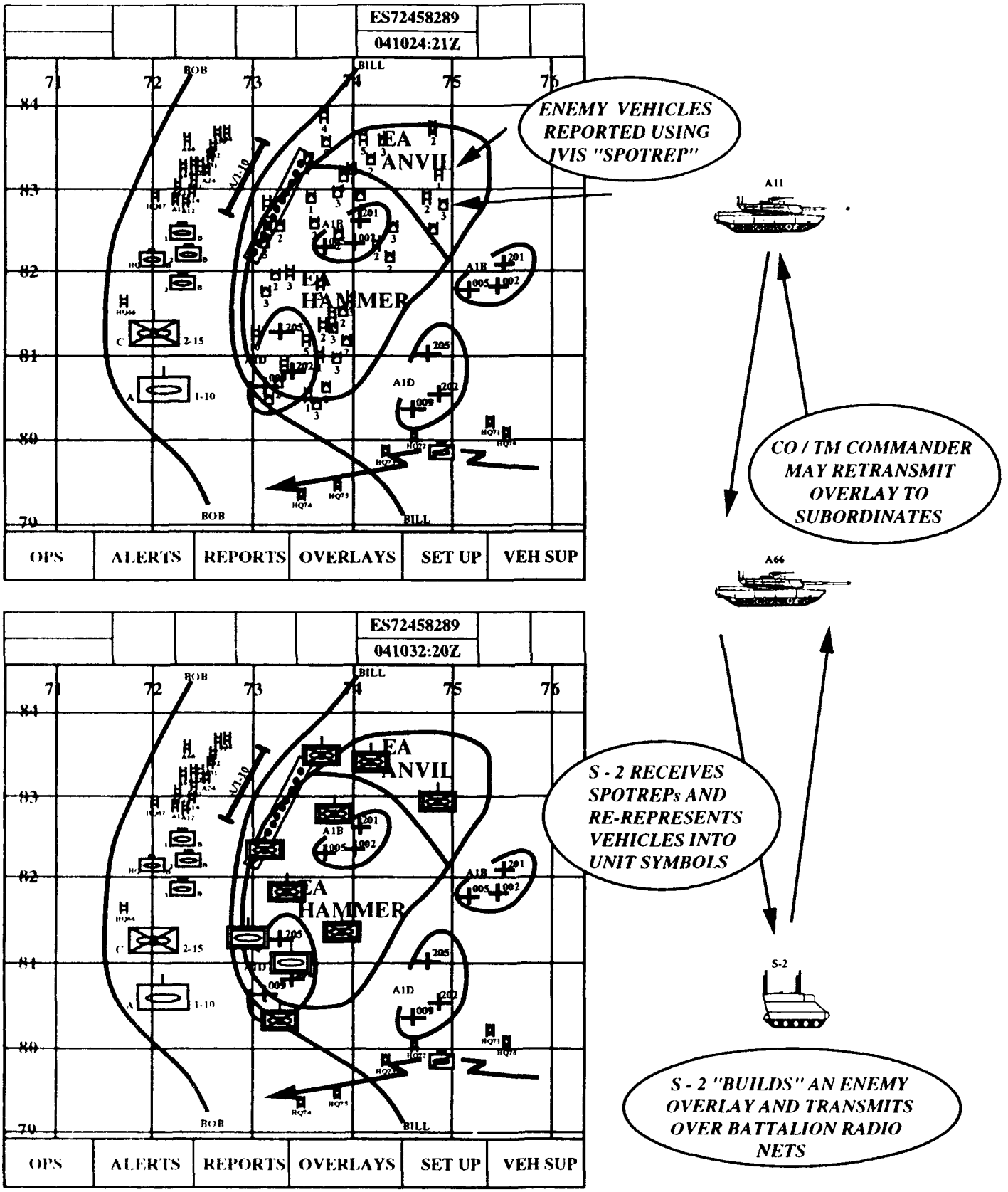


FIGURE 20. Enemy Situation Update Based on IVIS SPOT Reports - Combat Mode

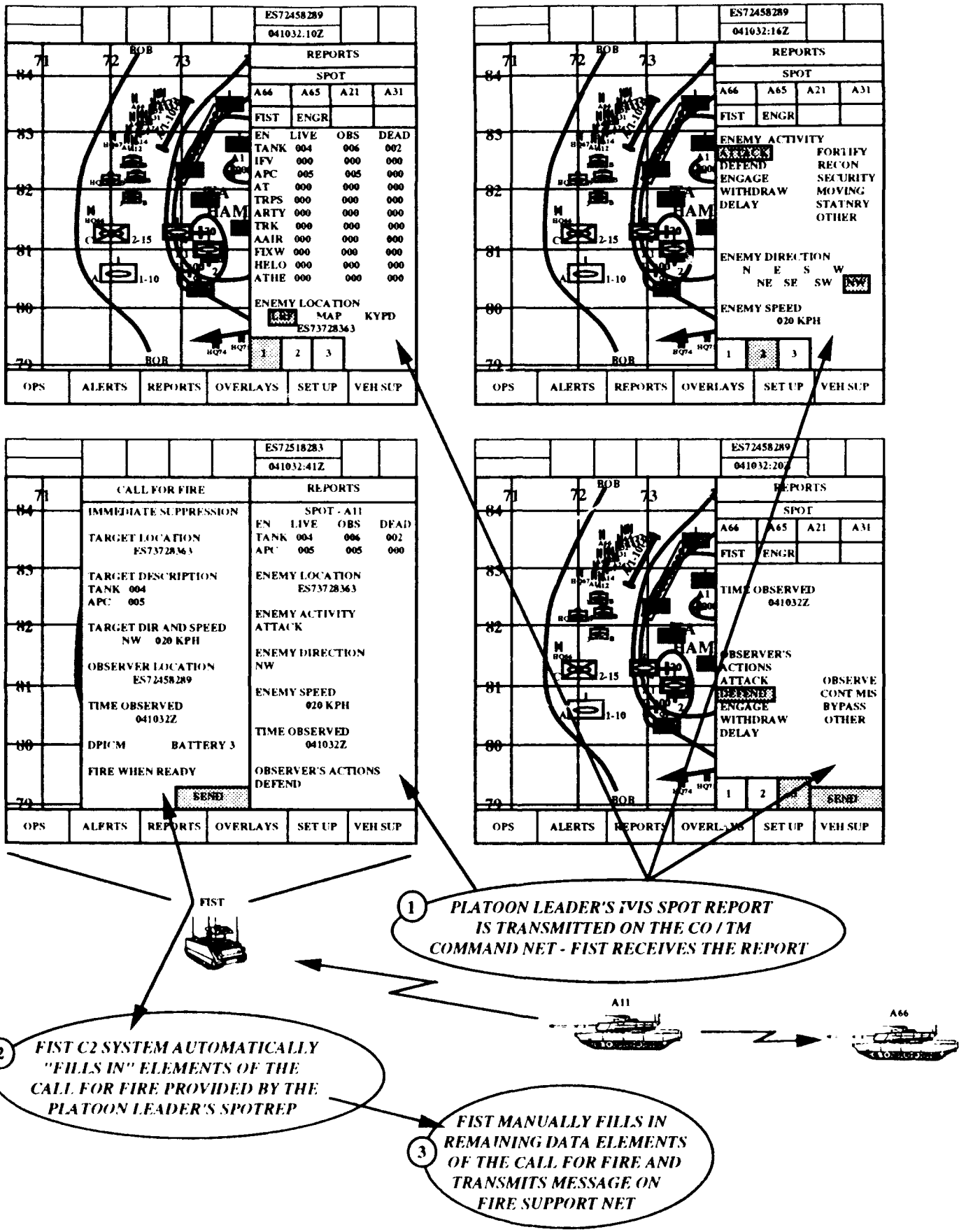


FIGURE 21. FIST Call For Fire Data Provided by IVIS SPOTREP - Combat Mode

c. The supporting elements of the company/team must also be able to develop and transmit tactical reports and admin/log messages that the unit leadership (CO, XO, 1SG) may need to consolidate into a company/team reports. Lack of this capability would severely restrict the use of IVIS data and information messaging within the company/team, and subsequently reduce the potential benefits of the system.

d. The XO is primarily responsible for developing and/or retransmitting company/team messages to the TOC during mission execution. This procedure allows the commander to concentrate on directing the maneuver and fires of the company/team, and to report orally to the task force commander on the company situation.

e. During the execution of the mission the 1SG is responsible for consolidating the admin/log status of the company/team and retransmitting it in IVIS report format to the CTCP. The 1SG does this by allowing the IVIS to consolidate all of the most recent platoon admin/log updates, or by using the IVIS to query each platoon leader's vehicle.

7. *Company level - IVIS graphics.* The use of graphics at the company/team level is similar to that at the platoon level, the primary difference being the amount of information displayed (typically up to task force level for commander and XO, vice team level for the platoon leader). Development of graphics to augment those that are already included in the scheme of maneuver are based on available time to input the graphics, and the enemy situation.

a. The company/team commander and XO both receive enemy situation updates from the TOC. The update provides the team commander with a quick "snapshot" of the enemy situation by displaying graphic symbols of enemy locations. As the S-2 updates the enemy situation on his C2 system terminal, he periodically transmits an overlay out on the task force command net (or the O&I net as well) (Figure 22 - top). The company/team commander can retransmit the overlay to the team's supporting elements and platoons.

b. Once received, the company elements can remove the current enemy situational overlay and then display the most up-to-date overlay (Figure 22 - bottom). This technique reduces the amount of FM voice radio transmissions from the TOC to the company/team commanders (and other members of the task force) and provides an easily understood representation of the enemy situation. It also provides the commander the ability to display the graphic overlay *when he has the time to do so*, enabling him to concentrate on the immediate fight rather than having to "stop everything" to monitor a lengthy update by the TOC.

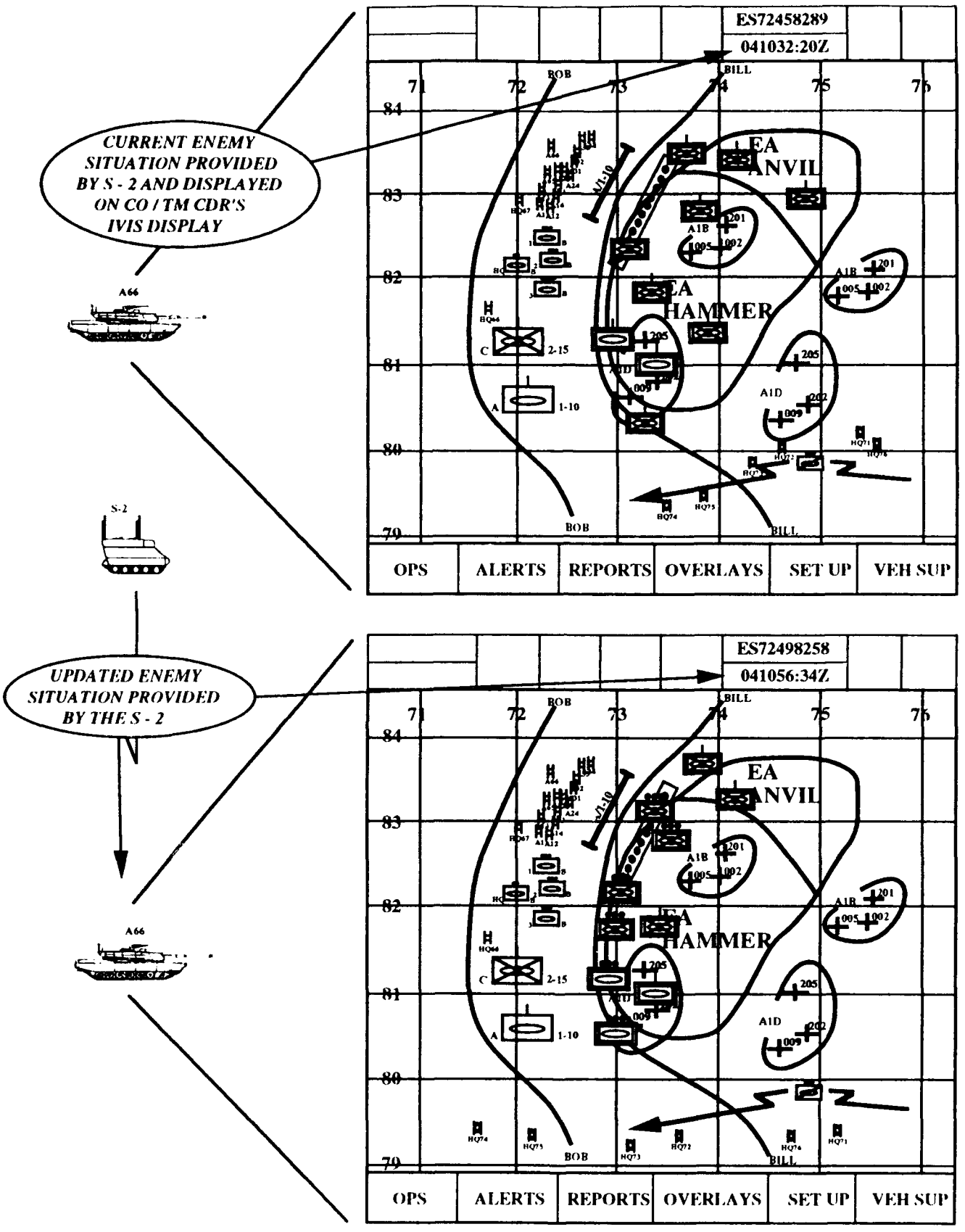


FIGURE 22. Enemy Situation Updates Provided by the S - 2 Via IVIS - Combat Mode

c. Based on time available to do so, the company/team commander can use the IVIS to develop operational graphics and/or control measures in support of a change of mission or scheme of maneuver. Graphic overlays can be transmitted using SINCGARS to **all** company/team elements, thereby eliminating the need to assemble all essential members of the team and significantly reducing the time and number of radio transmissions associated with a change of mission or scheme of maneuver.

8. *Battalion level - data/information messaging.*

a. *General.*

- The use of most IVIS messages is generally more suitable to the task force O&I and Admin/Log radio nets than the command net. IVIS data transmitted on the command net will primarily consist of position updates from subordinate company/teams, and those IVIS equipped support elements that operate on the command net. Graphic overlays will also be transmitted over the command net. Radio transmissions using FM voice will, however, remain the primary means of exchanging information among commanders on the task force command net.

- The O&I net provides a medium at task force level for transmission of some IVIS tactical messages to and/or from the TOC. The O&I net may consist of a mix of IVIS messages and overlays and FM voice transmissions. It is expected the O&I net will handle a moderately high volume of tactical, digitally transmitted IVIS messages so as to "free-up" the command net for what it is typically used for; general, situational reporting by commanders, and directions/orders from the task force commander and S-3.

- Lastly, the task force Admin/Log net transmissions will consist primarily of IVIS messages and some voice reports. This is chiefly due to the nature of the reports that are typically transmitted on the A/L net - preformatted, highly detailed, standard reports being the norm.

b. *Battalion level - Command Net.*

- *Data/information messaging.* The use of IVIS tactical messages on the command net during combat is based on the enemy situation (heavy vs. light contact), and the time available for commanders to interact with the IVIS CID and read specific messages. Generally, the command net will be reserved for FM voice transmissions between the task force commander and his subordinate commanders and staff (XO, S-3, FSO, Engineer, TOC, and CTCP).

oo Most reports from the subordinate commanders are delivered as *general* assessments of the tactical situation, enemy and friendly, in their area of interest. This type of

report is difficult to provide in a preformatted message, even a IVIS formatted SITREP. Providing situation updates by voice also frees the commander from having to access the IVIS message queue.

oo It is important to keep in mind that the intent of the IVIS is not to turn the **commander** (vehicle through task force) into a *processor of data*, but rather provide the commander with *tactical information* that he can view on his CID. Ideally, if the staff is performing its role as the *processor* for most tactical data that is transmitted on both the command and O&I nets, the commander need never "read" an incoming IVIS message from a subordinate. This allows the commander to concentrate on what he does best - **decision making and providing directives/orders.**

oo There will be instances when the staff and subordinate commanders will forward IVIS messages to the task force commander and/or S-3. These exceptional messages will typically be transmitted to provide the commander with an associated graphic (i.e., sending a Bridge Report so that the location of a bridge can be displayed on the commander's tactical display - see Figure 23), or with data that the commander has specifically tasked the staff or company/team commanders to provide in digitally transmitted form (as opposed to voice). Again, the commander cannot afford to be "tied" to his display for the purpose of *processing* messages. The tactical situation display is the tool that the commander uses to supplement his situational awareness by displaying enemy and friendly locations and situational data. Without IVIS, the commander must do this himself by making annotations on his acetate overlays or tactical map.

oo A IVIS message that is transmitted to the commander will be either an aggregation of similar messages received by subordinate commanders or elements (i.e., consolidated status/tactical reports of a subordinate's lower echelon elements), or a near-immediate retransmission of a subordinate's message (based on the urgency of the message).

oo Currently, no messages other than those in IVIS format are expected to be transmitted to the task force commander, S-3, or subordinate task force elements. The length, format, and visual presentation of higher level U.S. Message Text Format messages are not indicative of the short, concise messages that tactical commanders must receive from the TOC/CTCP. The TOC/CTCP will use IVIS message formats when transmitting *data* (vice *graphic*) messages to the commander and subordinate elements.

oo The elements on the command net will also exchange Position Update messages, thereby providing mutual position location of the subordinate forces (company/teams, scouts, mortars, etc.) operating on the command net.

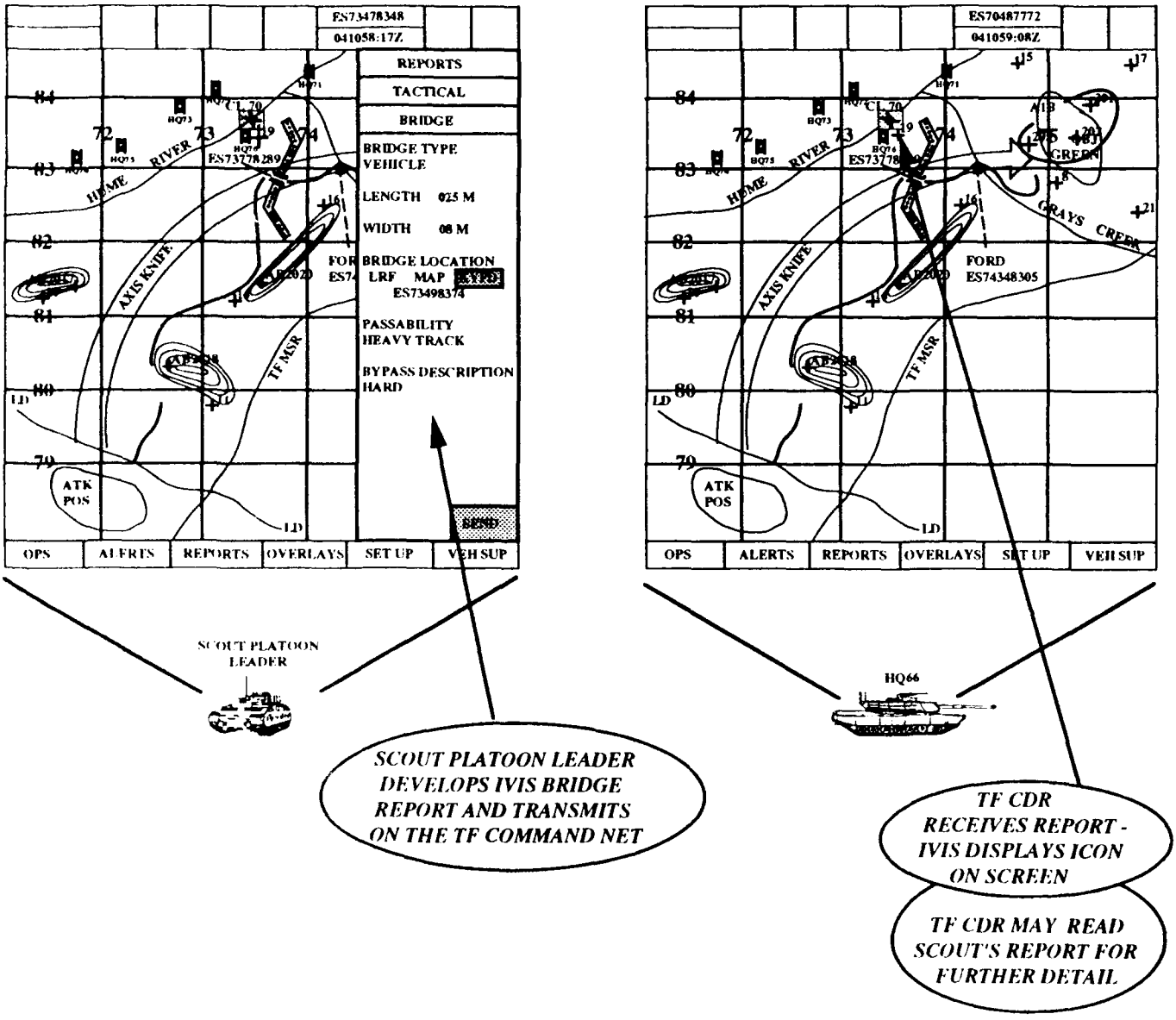


FIGURE 23. IVIS Reporting to the Task Force Commander - Combat Mode

- *IVIS graphics.* Most IVIS related graphics during combat will come from the TOC. The task force commander, his S-3, and the subordinate commanders and support elements will generally not develop IVIS graphics due to the conditions that they must operate under (limited time, enemy contact).

oo The TOC plays an extremely important role in a task force that has automated, interfacing command and control systems. The TOC performs the function of interpreting the tactical data and reports that are provided by task force subordinate elements, brigade staff, and other automated C2 systems that will be available to the TOC. The challenge for the staff is to present this *data* to the commander, S-3, and subordinate commanders **in a form that is easy for them to interpret and understand.** The staff does this by developing graphic overlays (enemy, friendly, obstacle, etc.) based on the data that has been transmitted to the TOC.

oo The staff uses its C2 system to develop the required graphic update. The update is then "translated" from the higher level C2 system format to IVIS format (using an embedded system translator within the battalion C2 system workstation) and transmitted on the command net. The elements receiving the incoming graphic "message" need only display the overlay once it has been entered through IVIS into to the system tactical database. In this case IVIS provides the elements on the command net with the ability to "un-post" out-of-date graphic overlays from their tactical displays, and then "overlay" the incoming graphic onto the CID's electronic map display. This method of providing a series of graphic overlays of the updated battlefield situation (enemy locations, obstacle locations, friendly locations) is supplemented with the mutual position locations of subordinate elements, and provides the commander with the "picture" that he requires of the battlefield area that he cannot personally observe.

oo The staff also uses its C2 system to develop graphics and execution matrices based on mission changes directed by the commander or higher headquarters. Mission graphics associated with a FRAGO received through an brigade to battalion transmission can be "supplemented" and/or altered to fit the task force commander's scheme of maneuver and tactical intent. The TOC could conceivably develop graphic overlays for the friendly maneuver, indirect fire support, and threat situation. The graphic overlay is then translated from TOC system to IVIS format prior to transmission on the command net. Once the mission graphic is received by the elements on the command net, each commander and support element can "post" the graphic overlay(s) for the upcoming mission (Figure 24). The task force commander can then either provide his mission intent by FM voice using SINCGARS, or can assemble the Orders Group for face-to-face discussion, rehearsals, and subordinate commander briefbacks (time and enemy situation permitting).

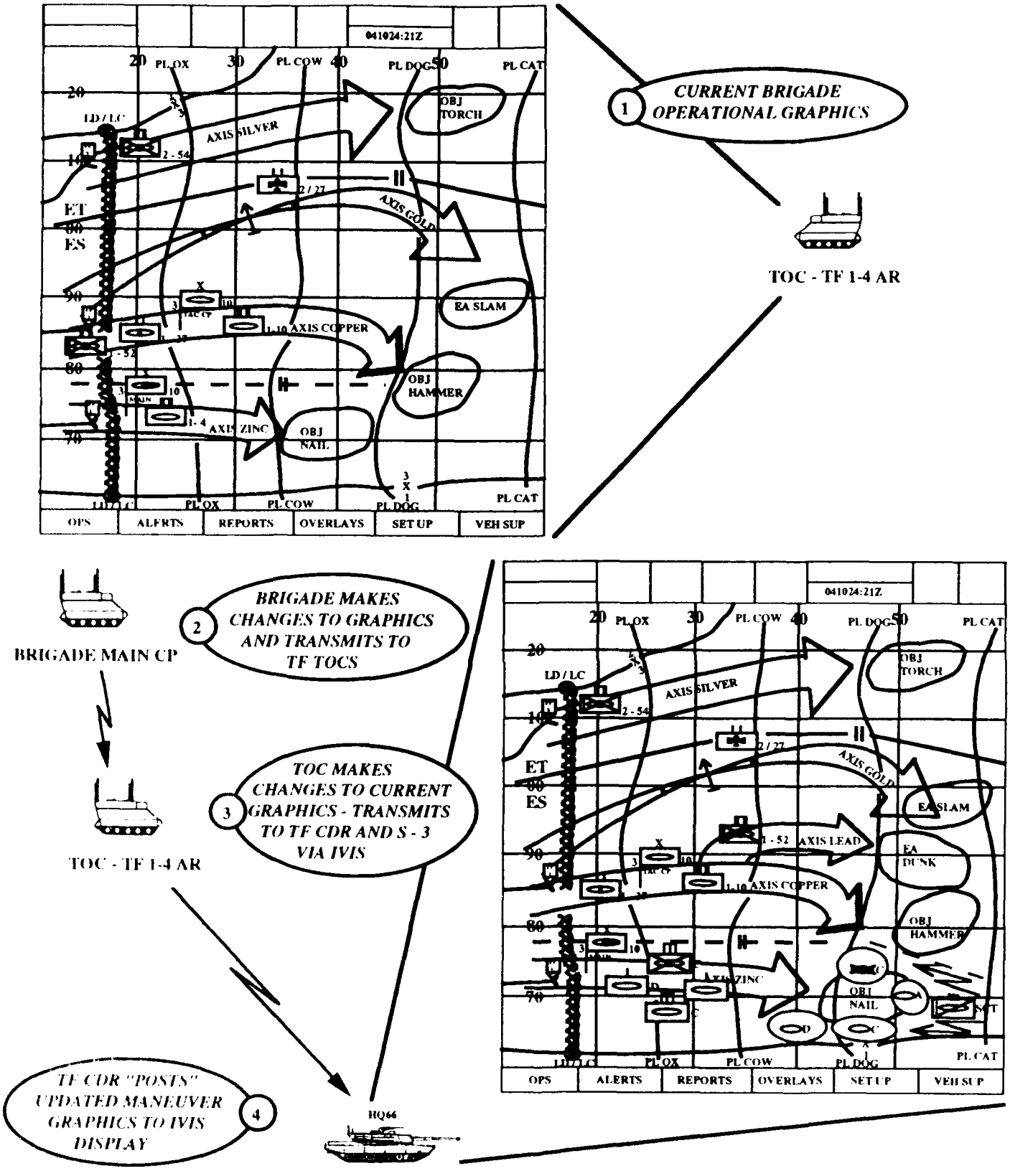


FIGURE 24 Brigade FRAGO and Supplementary Task Force Graphics - Combat Mode

oo Unlike current FRAGOS which are time consuming and difficult to issue by FM voice (especially graphic control measures, or which require the assembly of the Orders Group so that overlays can be distributed, the IVIS provides the commander and his staff with the capability to issue FRAGOs *on the move*. Both commander and TOC can be assured that the subordinate commanders and support elements have received the **same** graphics. Transmitting these graphics by digital message format using SINCGARS is expected to significantly reduce the net time required to issue a change of mission order.

c. *Battalion level - O&I Net.*

- *Data/information messaging.* The O&I net may serve as the medium by which task force subordinate elements (scouts, company/teams, etc.) transmit IVIS messages related to their general, tactical situation. Exceptions to this rule would include admin/log messages that are transmitted over the A/L net, or enemy situation reports (Contact, SPOTREP) transmitted over the command net. Use of the O&I net for transmission of some IVIS messages is based on the need to maintain a low volume of digitally transmitted messages on the command net, allowing it to be used primarily for voice communications, transmission of graphic overlays, or exchange of critical enemy situation reports (Contact and Spot Reports).

oo Tactical reports that are sent by subordinate elements of the task force to the TOC (and CTCP due to its role as the task force alternate command post) might typically be sent on the O&I net. The O&I net can serve as the means to transmit most IVIS messages that assist the TOC staff in maintaining situational awareness of subordinate units, but are not critical enough to be transmitted on the command net. The messages transmitted are typical of the friendly situation (SITREP) and changing battlefield geometry (Obstacle, SHELLREP, NBC reports).

oo It is expected that the O&I net will continue to host voice messages, however the number of voice transmissions should decrease as the use of IVIS messages increases. Because the use of IVIS messages is closely tied to time available (generally associated with the enemy situation) to the user to enter in the required message data, the use of IVIS messages by elements in contact may be relatively low. In this instance voice transmission will dominate IVIS digital messages, at least until a more sophisticated means of entering non-automated message data is developed.

- *IVIS graphics.* The number of transmissions of IVIS graphics over the O&I net during combat is expected to be relatively low compared to that of the command net. Most graphic overlays associated with enhancing situational awareness will be transmitted over the command net rather than the O&I net.

d. *Battalion level - Admin/Log Net.*

- Data/information messaging. The nature of data transmitted over the A/L net is well suited to the preformatted messages that the IVIS uses for reporting personnel, ammunition, and status of POL items. Most reports transmitted over the A/L net will be consolidated platoon (scouts, mortars, etc.) and company/team reports.

oo IVIS A/L reports are transmitted to the CTCP by either the platoon leader/sergeant of task force specialty platoons, or the 1SG/XO of the subordinate company/teams. These reports will be received at the CTCP via SINCGARS, translated into CTCP C2 system formatted messages, and stored in the S1/4 system databases. Display of A/L data to the S-1 and S-4 will be in their C2 system's display format. Forwarding of A/L data (generated by IVIS messages) to higher headquarters will be done via the IVIS parent system.

oo CTCP requests for company/team and specialty platoon A/L status will be done using the IVIS formatted Request for Report for personnel, ammunition, and POL. Generation of this report by the CTCP queries the recipient's IVIS system, automatically and transparent to the leadership/crew of the unit (commander, XO, or 1SG) or vehicle. The queried IVIS automatically develops the necessary message, providing the most current data within the IVIS database for the respective request.

oo The CTCP also receives consolidated unit status reports for personnel, ammunition, and POL based on when the unit falls below certain predetermined levels . The company/ team commander, XO and 1SG systems' databases maintain current status of the company/team vehicles and crews (based on platoon and supporting element reports), and the IVIS will automatically format a *consolidated* unit report for transmission to the CTCP via SINCGARS.

- *IVIS graphics*. Transmission of IVIS graphics from the subordinate company/teams of the task force includes, but is not limited to, location of unit ammunition prestock locations, company combat trains location(s), rearm/refuel points. Conversely, task force A/L graphics developed by the CTCP in support of the task force mission are typically transmitted with the OPORD graphics. These graphics are received and stored in the IVIS database, and can be displayed or removed in accordance with the wishes of the individual unit/vehicle commander. The ability to transmit these graphics to IVIS equipped unit commanders, and then retransmit them to all the vehicles within the unit, provides the capability for every IVIS equipped (or functionally equivalent) system to have the graphics that show the task force MSRs, collection points, combat trains locations, UMCP, and Aid Station location.

9. *Summary - combat.* The tactical conditions that IVIS equipped combat vehicle commanders face once contact with the enemy has been made make routine use of the IVIS, at least in the *manual* mode, difficult at best. During combat, the system is intended to **augment** the vehicle and unit commander's situational awareness. The automated functions that IVIS is capable of performing for the vehicle/unit commander significantly reduce tactical reporting requirements, especially position reporting.

a. Operating in a task force in which there is horizontal and vertical integration of automated command and control systems, the IVIS becomes the foundation for exchange of reports that feed the staff with data that it requires in order to sustain the commander with *information.* Use of IVIS reports is based on having adequate time to enter data into message data fields. Vehicle/unit commanders in contact will most likely revert to FM voice for transmission of reports, primarily due to the difficulty of simultaneously maintaining *visual* observation of the enemy, and information displayed on the IVIS CID. Under these conditions, the IVIS provides a means to **supplement** the vehicle/unit commander's understanding of the tactical situation by providing friendly and own vehicle/unit locations, graphic display of the enemy situation (provided by the S-2 through a TOC to IVIS interface), and display of operational graphics.

b. The ability of the IVIS to automate some of the routine, but essential, reporting of vehicle and unit commanders while in contact allows commanders to focus on the close-in fight. Simultaneously, the automatic transmission of vehicle/unit position reports and logistic reports (ammunition and fuel) maintains the flow of reporting that can speed-up the process of providing logistical resupply for the unit, or is essential in reducing the amount of FM voice radio traffic (by automating position reporting) during critical points in the operation.

c. IVIS capability for "far-target location" (using the laser rangefinder to designate a distant target) and reporting own vehicle location using the POSNAV significantly eases the task of vehicle navigation (using paper maps) for the individual vehicle commander. These capabilities are especially evident during periods of limited visibility, and while the commander attempts to fight his vehicle and/or unit.

d. The IVIS also provides a link with the C2 system that the staff uses to develop operational graphics that can enhance the situational awareness of the commander. The staff uses accumulated data from higher level sources, tactical reporting from subordinate elements, and situational monitoring

of adjacent units to provide the commander with a graphic *picture* that he and his subordinate commanders can "overlay" (and if desired, retransmit to their subordinates) onto his situational display.

e. Lastly, an IVIS interface with the TOC provides the commander and staff with the ability to develop change of mission graphics, then transmit them to subordinates via the SINCGARS. This capability provides a commander with the ability to react to mission changes *while on the move*, and without having to assemble the orders group for exchange of graphics. To a well trained unit, this capability can provide a significant advantage over a less technically sophisticated enemy.

6. Conclusion. The design of any command and control system for use in a combat vehicle must be such that it reduces the cognitive and physical workload of the individual vehicle commander, while simultaneously providing a means of exchange for tactical data and information. The IVIS does this by transmitting and displaying data and information that is essential in the commander's decision-making process. As a computer, the IVIS has built-in capabilities that individual vehicle and unit commanders can use to perform tasks and assist decision-making during the pre/post combat and combat phases of a mission. Proper training and fully developed tactics, techniques, and procedures, from vehicle to task force level, lay the groundwork for effective use of the IVIS. Understanding what the system can do for the vehicle and unit commander (under battlefield conditions that range from intense enemy contact to relative calm) must exist not only among the commanders that fight from IVIS equipped vehicles, but with the supporting elements at company/team and battalion/task force level alike. To realize the **full potential of IVIS**, it is essential that the system "interface" with the automated command and control systems of supporting elements at the company/team (1SG, FIST, Engineer Platoon/Section leader, etc.) and task force (TOC and CTCP) levels. Interface with other systems is based on the exchange of data and information that is essential to the performance of pre/post combat and combat tasks by combat, combat support, and combat service support elements. Creating these interfaces is critical to fielding a system that significantly increases the exponential benefit and effectiveness that the IVIS can provide to command and control at the battalion and below level of war.

ANNEX A: M1A2 Tank System Description

1. General. The following system description is centered around the core tank and its components. It is this collection of components that provide the vehicle and its crew with the set of system functions and capabilities that have been termed the Intervehicular Information System (IVIS).

2. Core tank definition. The M1A2 core tank is a term used to conveniently designate the collection of hardware, firmware, and software that must be modified or added to facilitate integration of mission modules (sometimes called subsystems). These modifications or additions are necessary to fully develop the data and power bused architecture featured in the M1A2 tank. The core tank is not a stand-alone system in and of itself, but by design is a technical means for systems integration within the M1A2 configuration.

3. Core tank components.

A. *Data management system (MIL STD 1553B Data Bus).* The MIL STD 1553B data bus system is the primary means for command and control of the M1A2 electronics system. The bus controller initiates bus transactions (messages) by issuing a command to the selected remote component. The remote component receives the command, receives or transmits data as directed, and responds with a status word. The command-response protocol implements the positive central control philosophy of the bus concept and ensures feedback on message status. This means that there is centralized control of data traffic on the bus, this eliminating bus contention. Line Replaceable Units (LRUs), or system components, "talk" only when the bus controller issues a command.

B. *Power management (RS 485 electrical interface).* The power control (utility) bus is used to allow the decentralization of electrical power distribution through the use of a low-cost, multidrop serial bus interconnecting remote programmable-controlled semiconductor switches to facilitate power control (and remote analog/digital modules to facilitate built-in-test [BIT]). The power bus uses an RS 485 electrical interface to a multidrop serial utility bus. This system replaces most of the turret networks box (TNB) and hull networks box (HNB) functions with respect to power management.

C. *Modified Slipring Assembly.* The slipring assembly provides the link between the hull and turret. The M1A2 has a modified slipring that accommodates the changed number of circuits required, including the redundant MIL STD 1553B data bus and power distribution utility buses, with shielding added to some circuits.

D. *Hull Electronics Unit (HEU).* The hull electronics unit provides the control, communications, and processing core of the hull electronics system. It includes the processing power to manage the power management bus and acts as backup bus controller for the MIL STD 1553B data bus. It essentially serves as the auxiliary system supervisor. It also provides engine diagnostics reporting and Position Navigation System (POSNAV) computation and management. The HEU communicates with the turret electronics unit (TEU) and provides two-way functional redundancy between the HEU and the TEU. If the TEU fails, the HEU will perform its critical functions and vice versa.

E. *Turret Electronics Unit (TEU).* The TEU provides the control, communications, and processing heart of the core electronics system. It is the primary system supervisor/ executive and manages the MIL STD 1553B data bus. It includes processing power for backup to the power management system. The TEU also provides fire control computations.

F. *Fire Control Electronics Unit (FCEU).* The Fire Control Electronics Unit replaces part of the Turret Networks Box (TNB), provides for system integration of the hunter/killer mode (using the Commander's Integrated Thermal Viewer (CITV)) and main gun firing, and incorporates the armament enhancements into the fire control system. It integrates the CITV with the fire control system through the Gun Turret Drive (GTD), line of sight (LOS)/data link and TNB fire control functions. It performs all current ballistic computer functions in addition to providing for dynamic cant data from the POSNAV system and the hull-turret position sensor.

G. *Hull-Turret Position Sensor (HTPS).* The hull-turret position sensor provides a signal to the FCEU which indicates the relative angle of the hull and turret. This angle is used to resolve the POSNAV hull roll and pitch angles to provide a turret dynamic cant signal. This replaces the current cant sensor when POSNAV is integrated into the M1A2 tank. HTPS also supports the concept of "far target" location (lasing to a target and getting an accurate 8 digit grid location for automatic input into preformatted tactical messages).

H. *Digital Engine Control Unit (DECU).* The digital engine control unit replaces the existing analog electronic unit (ECU) and provides improved control and monitoring of the engine system resulting in reduced fuel consumption and improved reliability. Additionally, the DECU provides extensive engine diagnostic information which is provided to the crew via the driver's integrated display (DID).

I. *Commander's Integrated Display (CID).* The CID is the tank commander's primary soldier-machine interface (SMI) with the M1A2 tank. It combines in a single unit the display and control of the CITV and the command, control, and

communications functions through the core electronics system. It replaces the current tank commander's panel (TCP). The CITV video display screen is a direct view device with sufficient resolution to allow the incorporation of daylight television viewing at a later stage without the need for internal modifications. CITV controls are collocated with the display. Control and display of communications, POSNAV, BIT, and other operator and tactical functions occupy the remaining area of the CID.

J. *Gunner's Control and Display Panel (GCDP).* The gunner's control and display panel provides the new interface required by the TEU's fire control computation function and continues to provide the control and display function of the replaced gunner's computer control panel (GCCP). The GCDP interfaces to the vehicle subsystems through its MIL STD 1553B data bus interface which provides the FCEU and TEU with data to calculate and resolve ballistics.

K. *Driver's Integrated Display (DID).* The driver's integrated display is the driver's primary SMI with the M1A2 tank. It replaces the existing driver's instrument panel (DIP), the driver's master panel (DMP), and the driver's alert panel (DAP); it provides all their control and monitoring functions. It also monitors all engine system status and control signals transmitted from the digital engine control unit (DECU) and communicates with the HEU. The DID also provides the driver with navigation information heading and "steer-to" display.

ANNEX B: Summary - IVIS Messages and Information Sharing

1. General. Much like current voice communications, IVIS messages convey friendly and enemy situations and conditions on the battlefield. The IVIS messages can also provide alerts, warnings, and can be used to request indirect fires and close air support. Use of IVIS messages is, in general, based on the time that vehicle and echelon commanders have to use the system, either to input data or read messages that have been transmitted on task force radio nets. The IVIS is also capable of transmitting messages automatically, based on the degree that the IVIS is integrated into the components and subsystems of the host vehicle. The IVIS is typically integrated into combat vehicles where the crew must perform multiple tasks in close proximity to the enemy (tanks, Infantry Fighting Vehicles, helicopters). Crews or leaders that do not employ direct fire against the enemy, or who are in supporting roles where contact with the enemy is discouraged (First Sergeant, FIST, Support Platoon Leader, Mortar Platoon Leader, etc.) will generally operate under conditions where they have adequate time to manually input data into IVIS messages, and thus do not require an integrated system.

2. IVIS Message Use Prior to Enemy Contact.

A. Most IVIS messages used prior to actual contact with the enemy will generally be more detailed and require more manual input of message data by the vehicle crew or echelon leader. Detailed messages may consist of overlays, orders, and personnel and logistics reports.

B. Even though IVIS messages used prior to contact with the enemy require manual interaction by the crew or leader, the IVIS will still be capable of performing certain computing functions for the system user (such as integrating individual vehicle logistic reports into echelon reports). This capability is true for non-integrated IVIS systems (i.e., lapheld computers used by a First Sergeant or Mortar Platoon Leader) and integrated systems alike (M1A2 or Bradley Fighting Vehicle).

C. IVIS messages must be capable of automatically "feeding" into higher echelon messages; this is especially true for administrative and logistic reports that must be forwarded to higher headquarters that also use automated C2 systems. Similarly, the combat support (CS) elements that are typically attached to combat organizations (i.e., FIST and Engineer Platoon attached to a tank company team) must utilize automated command and control systems that are capable of not only performing their specific CS functions, but are also capable of providing IVIS data required by the combat organization for mission planning (overlays) and mission support (admin/log reports). Attached elements must also be capable of receiving

and generating alerts (Air, REDCON, and NBC alerts) and operational reports (Contact Report, SPOTREP, SITREP, Obstacle Report, etc.).

3. IVIS Message Use During Enemy Contact.

A. IVIS messages used during enemy contact are short, concise, and utilize system automation to the maximum extent possible. Figure 18 provides an example of a completely automated Class V report that could be transmitted by IVIS without any action required on the part of the vehicle crew.

B. IVIS messages will be used by crews and leaders based on the time available to input any data that is not provided automatically by the system. During conditions where use of IVIS messages would potentially distract the vehicle or unit commander from the tactical situation in his area of influence, it is expected that personnel will use voice communications to provide tactically significant information.

C. Combat support elements attached to combat organizations must be able to receive and transmit operational reports that allow them to perform their support function, or that enables them to contribute to the situational awareness of the organization's elements. It is expected that the IVIS SPOTREP and SITREP will be used more extensively than any other reports with the exception of the Position Update message.

4. Figure B-1 contains a potential message set for use within the battalion/task force prior to, and during, enemy contact.

5. Figure B-2 illustrates IVIS tactical data exchange between echelons during the planning and execution phases of a combat operation.

POTENTIAL IVIS MESSAGE SET FOR ARMOR AND MECHANIZED INFANTRY TASK FORCE OPERATIONS

ALERTS

MOPP Status Alert
Air Alert
REDCON Alert
NBC Alert (Chemical Detection)

OVERLAYS AND ORDERS

Warning Order
Operations Order
Fragmentary Order
Operations Overlay
Enemy Overlay
Obstacle Overlay
Fire Support Overlay
Fire Plan
Sector Sketch

CALLS

Call for Indirect Fire
Call for Close Air Support

MISCELLANEOUS

Position Location Update
WILCO
Request for Report

OPERATIONAL REPORTS

Contact Report
Spot Report
Situation Report
Bridge Report
Minefield Laying Report
Obstacle Report
Route Report

PERSONNEL / LOGISTICS REPORT

Personnel Status
Ammunition Status - Precombat
Ammunition Status - Combat
POL Status - Precombat
POL Status - Combat
Vehicle Status

NBC AND SHELL REPORTS

NBC 1 Report
NBC 3 Report
NBC 4 Report
NBC 5 Report
Shell, Bomb, and Mortar Report
Strikewarn

FIGURE B - 1. Potential IVIS Message Set

IVIS TACTICAL DATA EXCHANGE AMONG ECHELONS

MISSION PLANNING

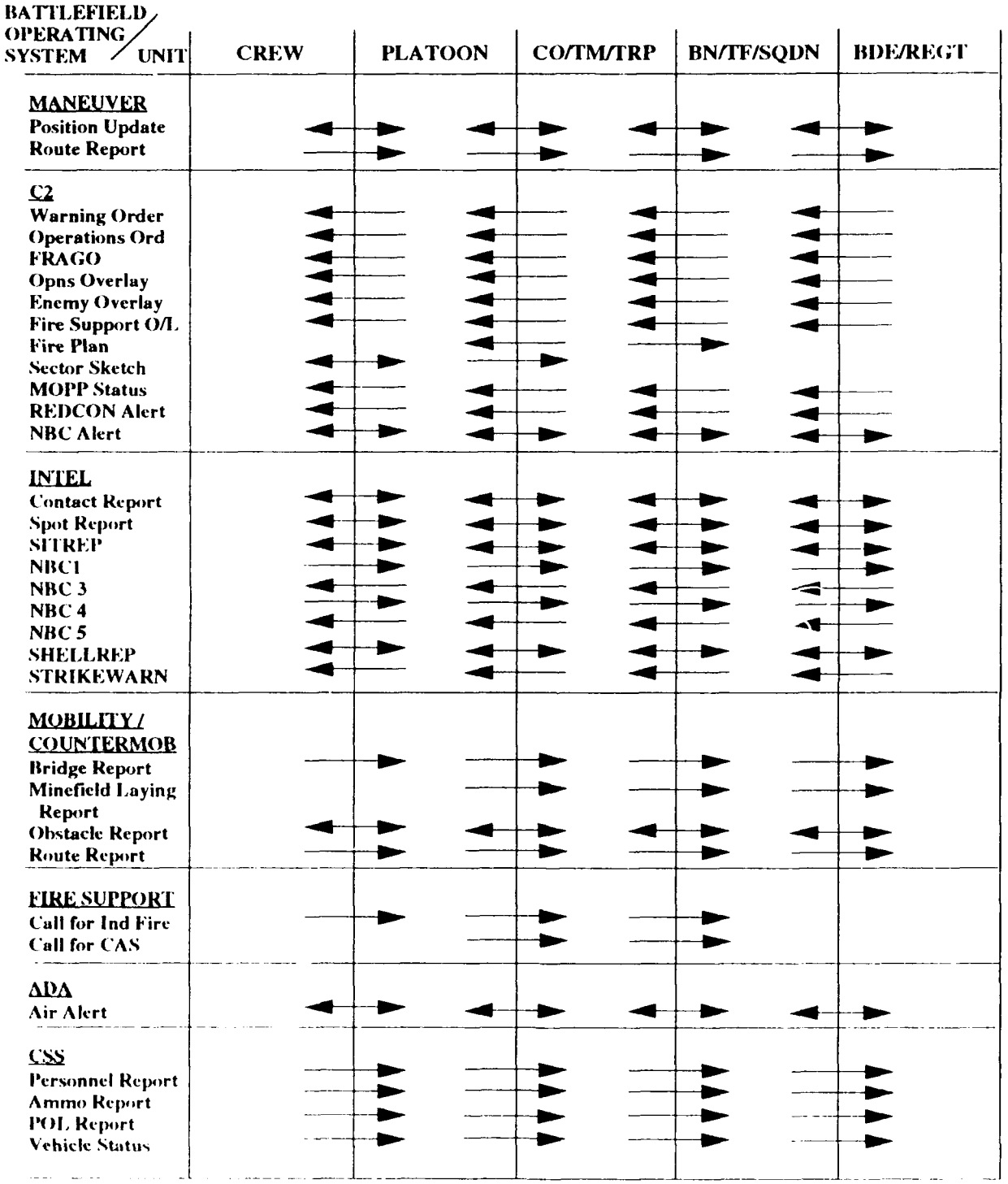


FIGURE B - 2a. IVIS Tactical Data Exchange During Mission Planning

IVIS TACTICAL DATA EXCHANGE AMONG ECHELONS

MISSION EXECUTION

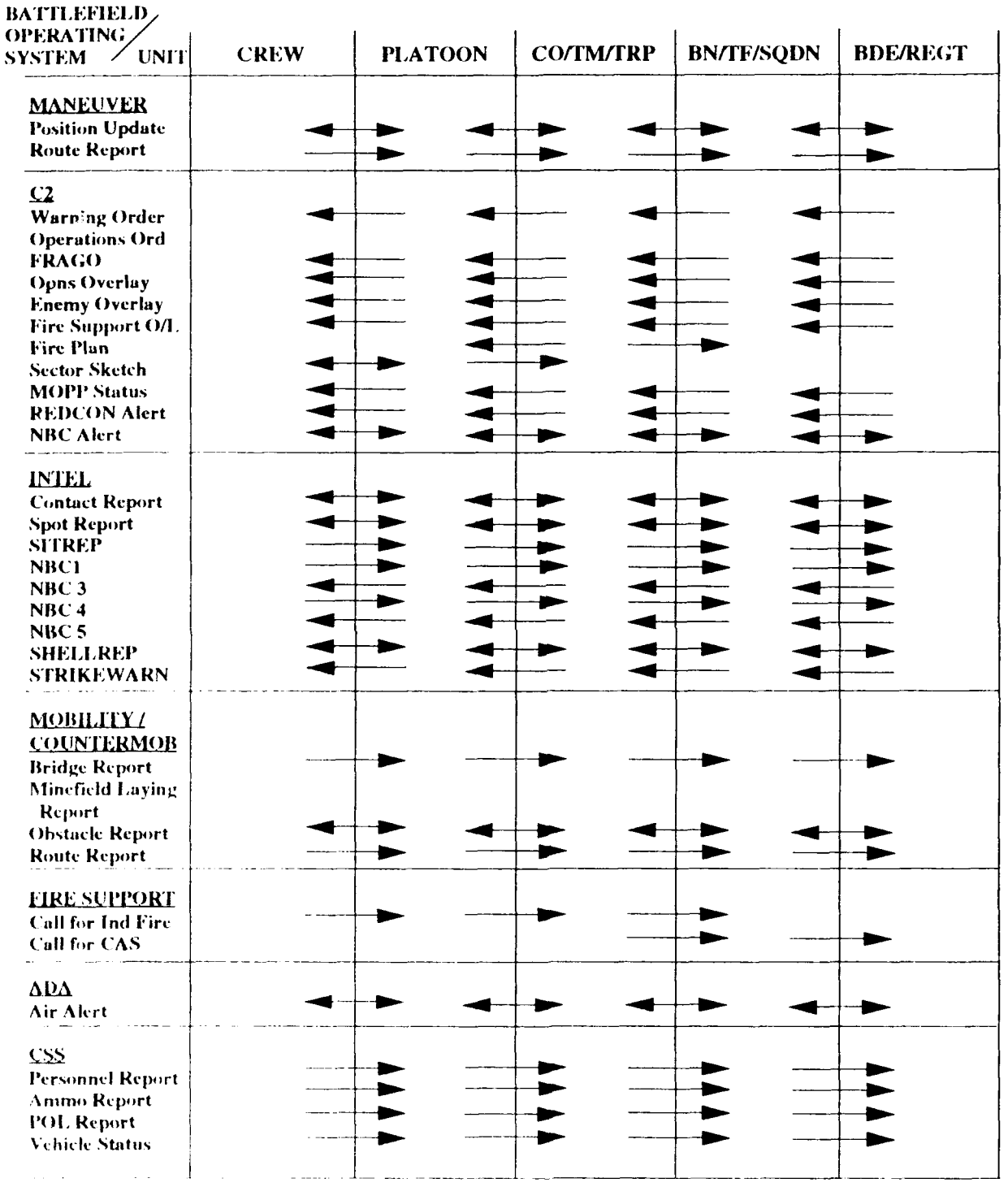


FIGURE B - 2b. IVIS Tactical Data Exchange During Mission Execution

ANNEX C: Exchange of IVIS Tactical Information Between Aviation and Ground-Maneuver Forces

1. General. The exchange of tactical data between Aviation and Armor and Mechanized forces using "IVIS like" systems is complicated by the fact that these forces operate together under two very distinct organizational relationships:

A. *OPCON Aviation.* Elements of the divisional aviation brigade may be placed under the operational control (OPCON) of a ground-maneuver brigade commander to accomplish a mission or for the duration of an operation pursuant to the division commander's concept of the operation. Aviation units under the OPCON of the brigade must be completely integrated into the brigade scheme of maneuver. The IPB process identifies specific potential targets for aviation. The maneuver commander then gives specific tactical missions to his aviation assets.

B. *Organic Aviation.* Organic Air Cavalry elements of the Armored Cavalry Regiment or the Divisional Armored Cavalry Troop are used by the ground force commander to reduce the enemy reaction time and provide more reaction time for the friendly main body. Once the battle is joined, air cavalry should not be relegated to rear areas, but should be used with other maneuver elements. Although the primary roles of air cavalry are reconnaissance and security, it may assume the roles of an attack helicopter unit if the mission dictates.

The use of IVIS at either the task force or squadron level is potentially different due primarily to the dissimilar command and control relationships (OPCON vs. organic) under which assigned aviation assets provide mission support. Figure C-1 lists some of the potential differences that must be considered when using IVIS in Armor or Cavalry organizations to support mission coordination and execution between ground and aviation elements.

C. The use of the terms "IVIS like systems" or "IVIS" is not meant to imply that aviation platforms must take on hardware specific to the M1A2 tank (as described in Annex A). An ideal developmental strategy to create "IVIS like" *functions* as described in the body of this concept (see paragraph 4.B.1.) would mandate the continued refinement and eventual merging of the M1A2's command and control (C2) system, commonly known as IVIS, with existing or planned aviation C2 systems. This approach would primarily be software driven, with some compatibility in hardware necessary to ensure adequate and effective communication and display of tactical information.

D. The use of IVIS to support execution of air-ground operations can be segregated into two key functional areas - situational awareness and target handover.

ARMOR TASK FORCE	*POTENTIAL DIFFERENCES*	DIVISION / REGIMENTAL CAVALRY
• MUST BE TRANSMITTED BY GROUND TASK FORCE UPON MISSION ASSIGNMENT	• AVAILABILITY OF MISSION GRAPHICS DUE TO ORGANIZATIONAL RELATIONSHIPS	• EXCHANGED BETWEEN AVIATION AND GROUND UNITS AS PART OF MISSION BRIEFING AND PREPARATION
• VEHICLES ARE LESS DISPERSED = ABILITY TO RELY MORE ON UNIT SYMBOLS FOR SITUATIONAL AWARENESS OF FRIENDLY LOCATIONS	• DISPLAY OF POSITION LOCATIONS OF GROUND ELEMENTS FOR SITUATIONAL AWARENESS	• GREATER DISTANCES BETWEEN VEHICLES = NEED TO DISPLAY VEHICLES / UNITS AT LOWER LEVELS OF RESOLUTION
• ENEMY SITUATION IS MORE DEFINED UPON ASSIGNMENT OR ARRIVAL OF AVIATION SUPPORT	• EXCHANGE OF ENEMY SITUATION	• AVIATION WORKS WITH GROUND ELEMENTS TO DEFINE ENEMY SITUATION

FIGURE C - 1. Potential Differences Between Armor and Cavalry Organizations in Use of IVIS to Support Air - Ground Mission Execution

1. *Situational Awareness.* The IVIS can be used to enhance situational awareness of aviation and ground forces in terms of: providing and displaying position location(s) of friendly forces onto C2 system displays; providing enemy situation information, both in message and graphics form; and, providing friendly situation information both in message and graphics form.

2. *Target Handover.* The IVIS can also be used to effect target handover between aviation and ground forces. It is logical to assume that *most* instances of target handover will be in the form of aviation elements providing targeting data (Spot Reports) to ground forces due to the aviator's ability to obtain a "bird's eye" view of the battlefield. One should also recognize that the specific data required to conduct target handover (size, location, etc., of the enemy) between aviation and ground elements will also complement the situational awareness of either element. The primary purpose of using IVIS to effect target handover is to extend the commander's knowledge, or "view" of the enemy, so that he may decisively engage him using maneuver and long-range fires. This mandates the exchange of IVIS target handover data between commanders (air and ground) and their C2 centers, but there may be instances where this is not the case. In fact, the command and control and mission relationships between aviation and ground forces within cavalry organizations may provide many opportunities for helicopters and tanks to operate together in a "hunter-killer" fashion.

As stated above it appears that the exchange of tactical data between aviation and ground forces consists, in general, of no more than:

- *Friendly operational graphics that provide situational awareness (control measures) and mission direction (axes of advance, objectives, battle positions, engagement areas);*

- *Enemy situation updates that provide enemy location and possible intent;*

- *IVIS position updates that provide the location of friendly elements within the aviation area of operations, and that can be tailored to meet the aviation commander's situational awareness needs (see description of tailoring position location updates at paragraph 7.E.2.e.);*

- *Spot Reports that contain the necessary data to provide target handover from aviation elements to ground elements and vice versa; and,*

- *Situation Reports that contain the necessary data to allow aviation elements to provide the ground commander with a battle damage assessment of engagements with the enemy.*

Figure C-2 illustrates the concept behind providing much of the above IVIS information. It also shows that the display of the information may differ based on the situational awareness needs of the individual commander.

2. Use of IVIS Information in Support of Aviation and Ground Force Tactical Operations.

A. *General.* As Figure C-1 illustrated there are potential differences in how IVIS information and functions might be used to enhance the synchronization of aviation elements in support Armor and Cavalry forces. Of these two forces, it is logical to assume that the use of IVIS to coordinate aviation support for Armor task force maneuver operations is more complex than the coordination of aviation and ground forces within the cavalry regiment or divisional cavalry troop; this is due primarily to the fact that the cavalry forces maintain organic aviation assets, and that these assets routinely perform missions for the cavalry force commander. The following discussion will therefore center on the more complex support relationship - aviation in support of an armor task force. It should be recognized, however, that many of the following concepts could just as easily apply to the coordination of aviation-ground maneuver using IVIS within a cavalry organization.

B. *Situational Awareness.*

1. *Conditions.* Attack helicopter battalions augment the maneuver brigade's fire support and maneuver capability and are most effective when massed against exposed, moving armored targets. Aviation units placed OPCON to the maneuver brigade remain the responsibility of the aviation brigade for logistics support. Therefore, the exchange of IVIS logistics reports between the aviation battalion and the maneuver brigade's Forward Support Battalion may not be required in order to sustain the tempo of the operation. The attack helicopter battalion is normally employed under brigade control.

2. *Synchronization of attack helicopters in support of the Armor task force.*

a. The maneuver battalion/task force will rarely receive aviation assets to solely support its tactical plan, but may normally be required to work closely with aviation units in support of a brigade or division scheme of maneuver. The attack helicopter battalion commander maneuvers his forces while working closely with the armor or mechanized infantry battalion/task force commander. Coordination is made by either the attack helicopter battalion commander or the attack helicopter company commander with aircraft actually on station. If at all possible, this coordination is conducted face to face.

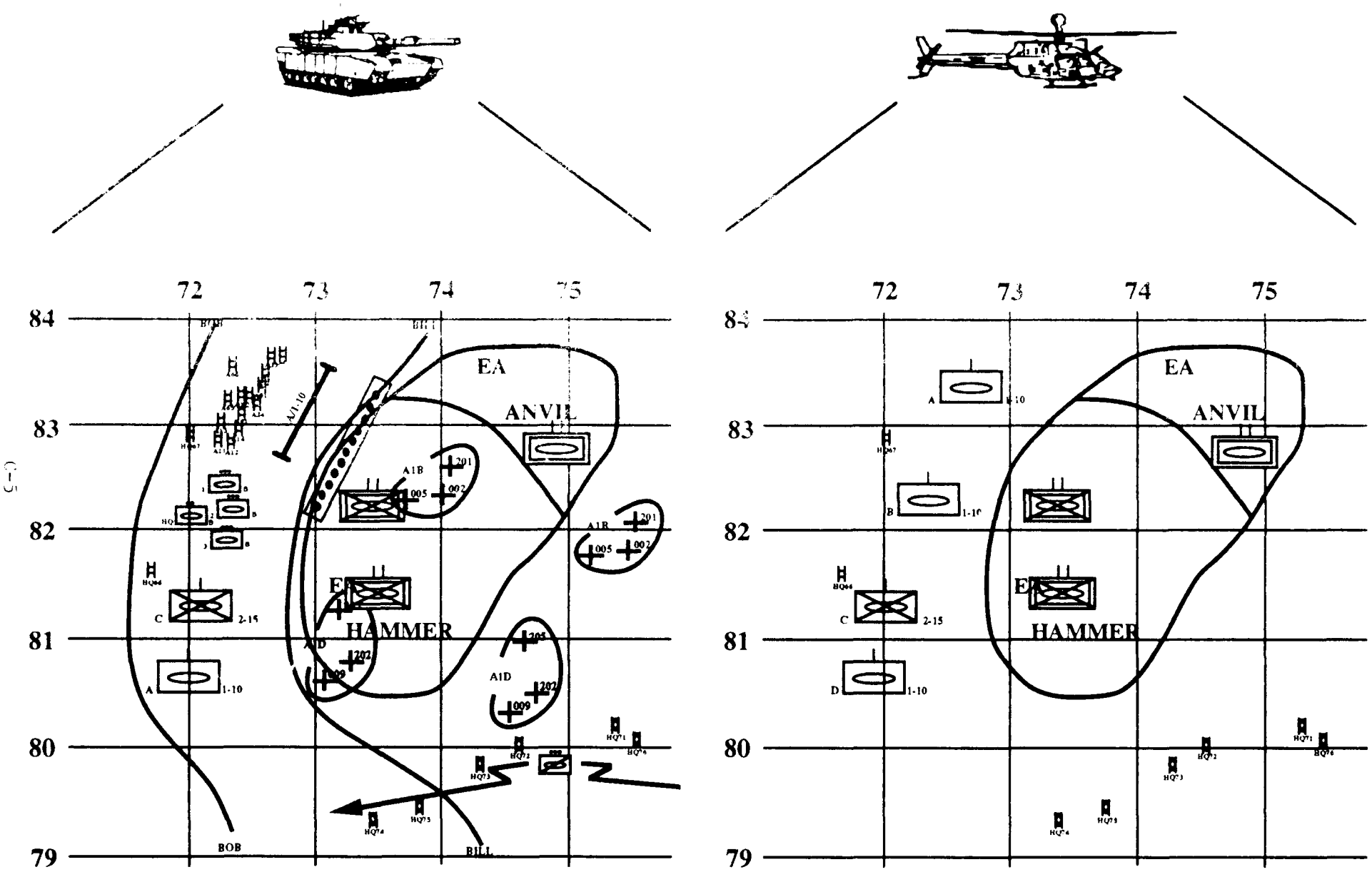


FIGURE C - 2. IVIS Information Tailored to Situational Awareness Needs

b. During the course of aviation support to the brigade, the attack helicopter battalion may be given a mission to support the brigade commander's main effort in close coordination with the ground attack or defense. Most initial mission graphics to support the brigade's scheme of maneuver should be exchanged using higher level automated C2 systems (and in hard copy) during the brigade's orders development process.

c. As the aviation commander is preparing to support the main effort, *either* the brigade or supported task force Tactical Operations Center (TOC) transmits any changes or updates to the original mission graphics using the C2 systems at either location. The C2 information maintained at the TOCs and transmitted to either the attack helicopter battalion commander or the supporting attack helicopter company commander (either enroute or on station) includes:

- *Updated task force mission graphics and control measures;*

- *Enemy situation updates based on IVIS SPOTREPs received by the S-2;*

- *IVIS position location updates of task force vehicles; and,*

- *Firing/battle positions, engagement areas, entry and exit routes, and attack positions (if not already available based on the brigade's original scheme of maneuver).*

d. As the attack helicopter company maneuvers along its designated routes, the aviation company commander enters into the task force command net and receives additional verbal guidance from the supported task force commander, any updated mission graphics from the task force TOC, and the most current IVIS position location updates of the task force vehicles. As the aviation force engages the enemy, the aviation company commander provides IVIS information on:

- *The enemy, using IVIS SPOTREPs or voice communication. Much like the use of IVIS by ground forces during combat the use of the IVIS SPOTREP is dependent on time available and the enemy situation;*

- *Battle damage assessment or effect against the enemy (IVIS SITREP format); and,*

- *Location of helicopters on station using IVIS type position updates.*

3. *Areas to consider when exchanging IVIS data between aviation and ground forces.* Figures C-2 and C-3 provide an indication of what points to consider when exchanging IVIS data and information between aviation and ground forces. Aviation C2 systems, much like the IVIS, must be capable of "tailoring" the automated C2 information presented on the crew display. This is especially true of IVIS position updates; the aviation crew should only display what is needed to maintain sufficient situational awareness after considering line-of-sight to the ground forces' vehicles and on-board weapons engagement ranges. Similarly, the amount of friendly and enemy information provided to the aviation company commander should be only that which is sufficient and necessary to enhance the aviation force's situational awareness. Filtering of IVIS enemy and friendly situational awareness data and graphics can be done by either the task force TOC staff, much as it does for the task force commander, or by the aviation commander on his own "IVIS like" tactical display.

C. *Target Handover.*

1. *Conditions.* The process of using IVIS to hand over targets from aviation assets to ground forces is primarily dependent on:

- *Time available to provide sufficient targeting information; and,*

- *The overall tactical situation.*

While it might be feasible for aviation assets to locate and hand over targets for ground maneuver forces, this relationship is most likely the exception to standard practice and is generally confined to cavalry operations. The use of aviation in the role of "hunter" for the ground force "killer" is very conducive to using the IVIS for exchange of targeting data, and would essentially allow the ground force or vehicle commander (tank, Bradley, or FIST) to "see" the enemy well beyond line-of-sight. Use of aviation to support this type of operation must of course be supportive of the commander's intent and scheme of maneuver.

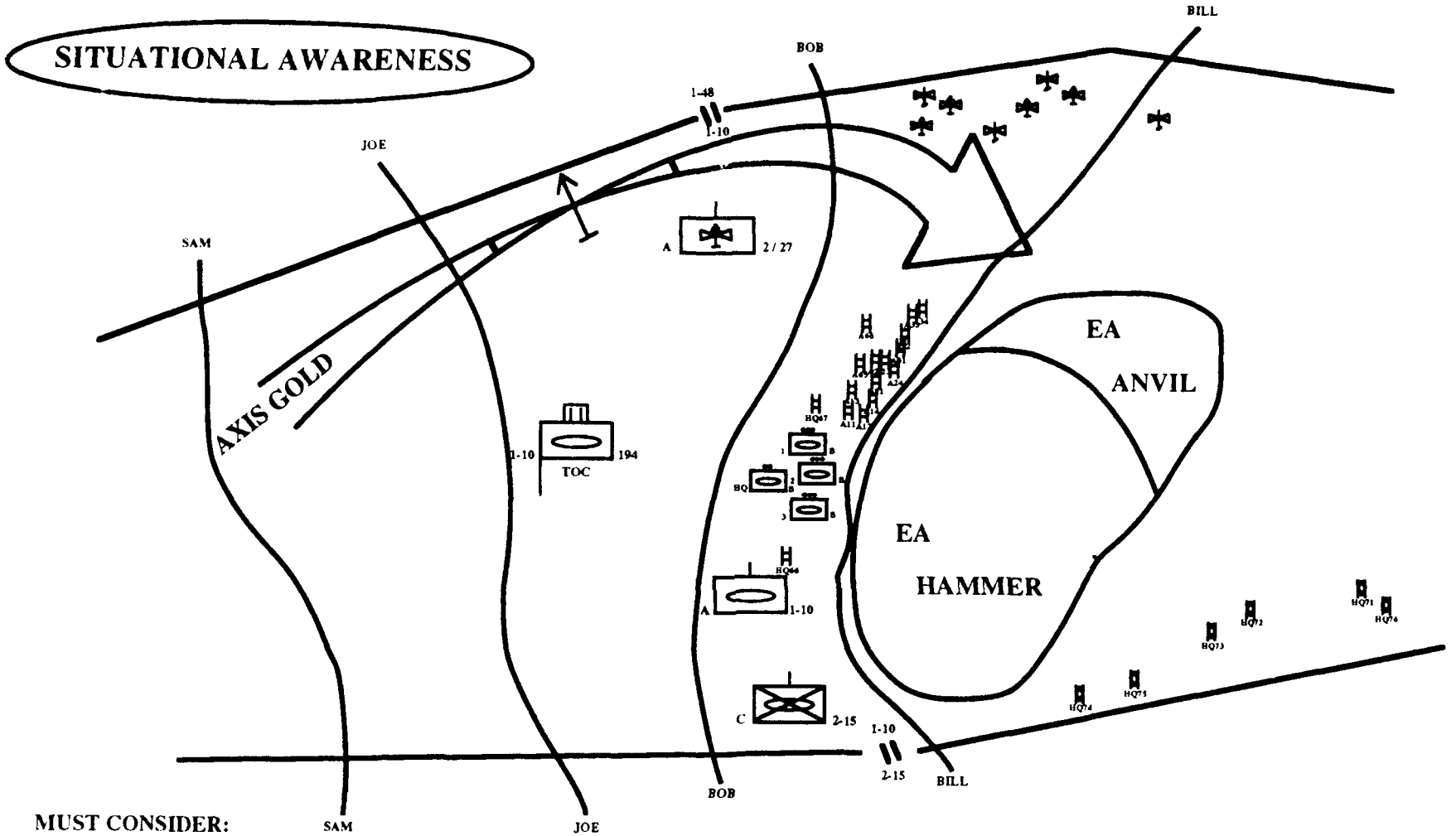
2. *Exchange of IVIS data in support of target handover.*

a. Exchange of data via an aviation to ground C2 system IVIS link would use a SPOTREP type format that provides:

- *Enemy location and direction;*

- *Type of enemy (armor, infantry, etc.);*

- *Enemy strength;*



MUST CONSIDER:

- POSITION LOCATION RESOLUTION - IMPACTS ON:
  - SITUATIONAL AWARENESS NEEDS
  - COMPLEXITY OF AGGREGATION
  - COMMUNICATIONS / COMPUTER LOAD
- ESSENTIAL GRAPHICS TO PERFORM MISSION
  - ENEMY SITUATION
  - FRIENDLY C2 GRAPHICS

FIGURE C - 3. Considerations When Exchanging IVIS Data Between Aviation and Ground Forces

- *Enemy activity; and,*

- *The action of the observer.*

This data is transmitted to the task force TOC for inclusion into the overall enemy situation, and via IVIS to the task force commander. The TOC must determine what the transmitted SPOTREP of the enemy force means in terms of:

- *The current situation;*

- *Friendly forces that might be required to engage to engage the enemy (required force ratio);*

- *What supporting fires (indirect) might be used to either destroy the enemy or support a maneuver force employed to do so;*

- *Time and distance factors; and,*

- *What maneuver would be required to effectively engage the enemy force.*

b. The TOC supports the task force commander by quickly developing a course of action, based on the above considerations, that will effectively engage the enemy (Figure C-4). Figures C-5 and C-6 further illustrate the conditions and planning sequence that takes place during aviation to ground force target handover. In this vignette the aeroscout is able to acquire an enemy force that would otherwise be masked by terrain to the maneuvering ground force. The aeroscout transmits an IVIS SPOTREP depicting the size, location, and movement of the enemy force to the commander and his TOC. The TOC weighs this data against the commander's bypass criteria and provides a feasible course of action to the commander.

c. The TOC provides the commander with a proposed scheme of maneuver (Figure C-6) that would move subordinate forces into positions from which to engage the enemy. The aeroscout is directed by the task force S-2 to move into a position from which it can provide IVIS SITREPs, giving the commander and S-2 near real-time battle damage assessment of the engagement. The location of the aeroscout depicted on the task force commander's display would provide him with adequate situational awareness that he can still employ indirect fires without fear of endangering the helicopter.

3. Conclusion. The use of IVIS information to enhance situational awareness and affect target handover between aviation and ground maneuver forces is no more complex than using the system to coordinate combat operations within the Armor task force. Many of the IVIS functions used within the Armor task force are applicable to operations with aviation

TARGET HANDOVER

- TARGET HANDOVER IS:
  - •• TIME DEPENDENT
  - •• DEPENDENT ON THE OVERALL TACTICAL SITUATION

- ENEMY LOCATION
- TYPE ENEMY
- ENEMY STRENGTH
- ENEMY ACTIVITY
- OWN ACTION

- EXCHANGE OF TARGETING DATA (SPOTREPS) SHOULD GENERALLY GO TO:
  - •• C2 CENTERS; AND
  - •• COMMANDERS

  OF FORCES THAT CAN AFFECT THE ENEMY

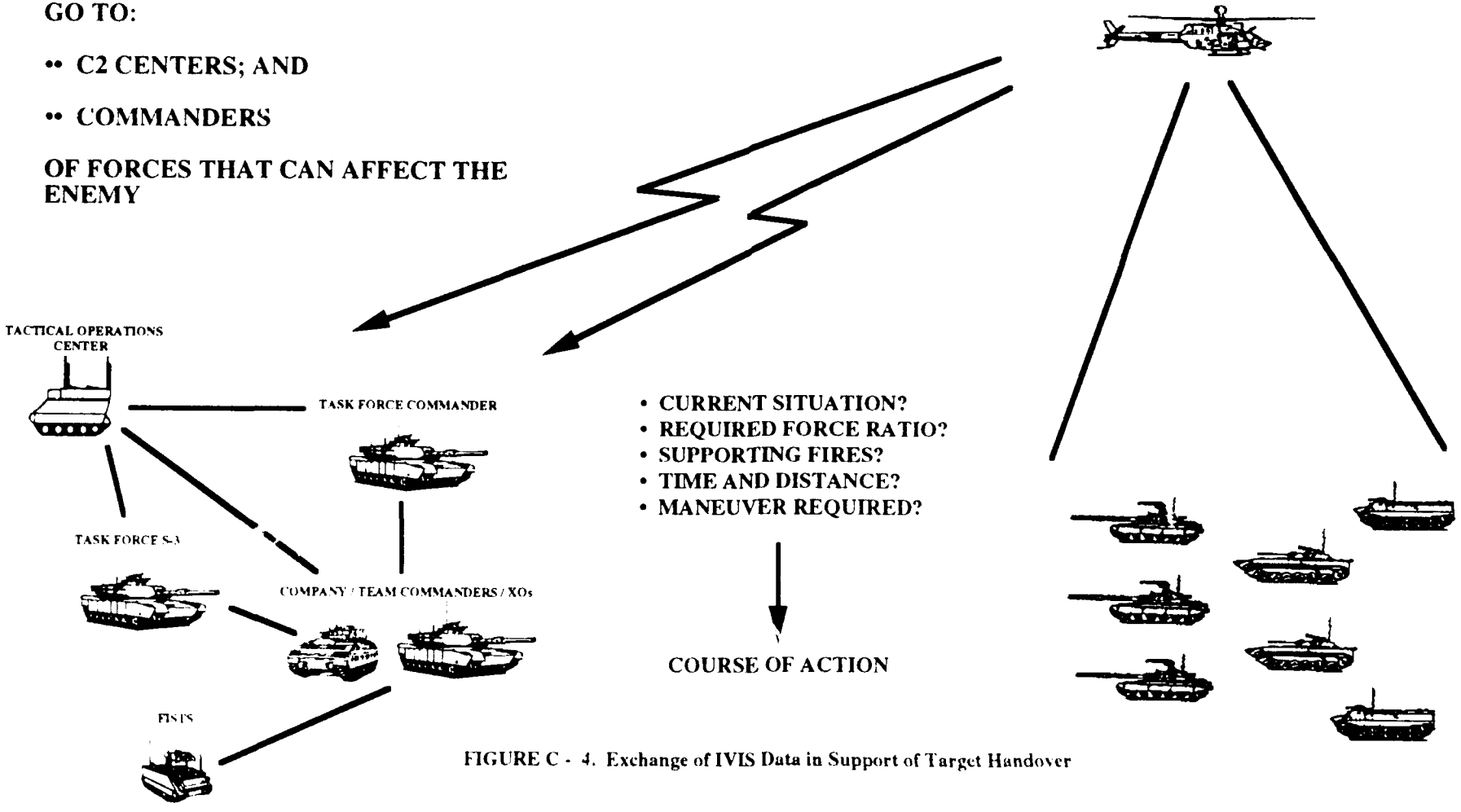
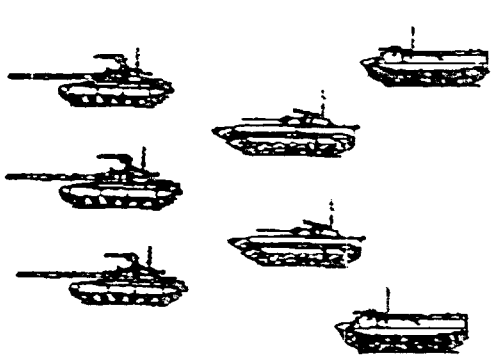


FIGURE C - 4. Exchange of IVIS Data in Support of Target Handover



FOUND THE ENEMY

- LINE OF SIGHT MASKED BY TERRAIN
- HAS ACCURATE PICTURE OF ENEMY LOCATION, SIZE, TYPE, AND ACTIVITY
- CAN TAKE ACTION USING INDIRECT FIRES AND MANEUVER

TASK FORCE COMMANDER

COURSE OF ACTION

TACTICAL OPERATIONS CENTER

FSE

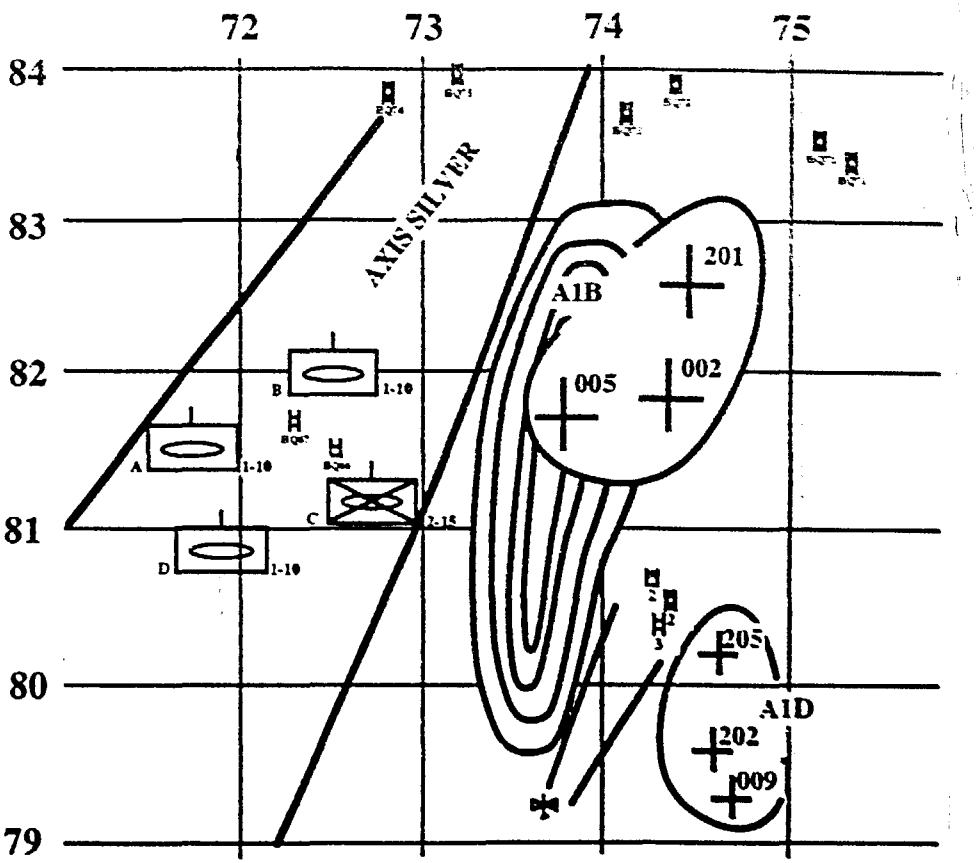
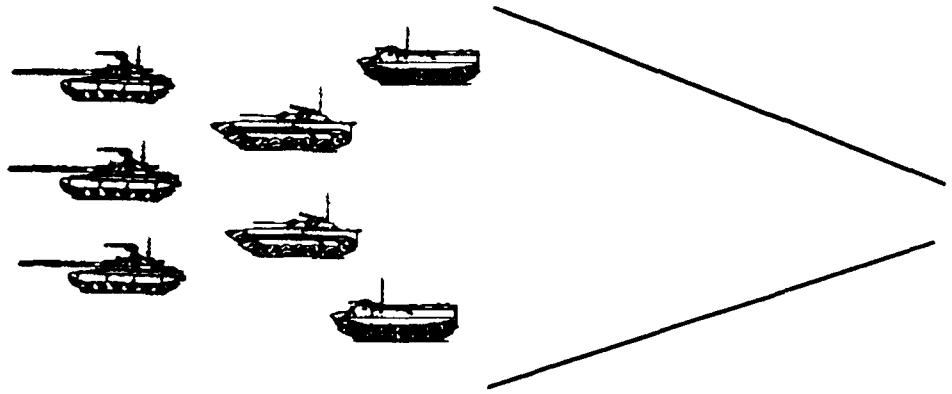
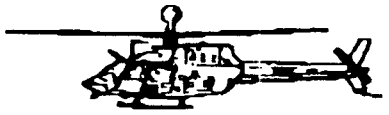


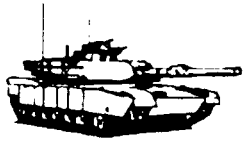
FIGURE C - 5. Target Handover Sequence



FOUND THE ENEMY



- LINE OF SIGHT MASKED BY TERRAIN
- HAS ACCURATE PICTURE OF ENEMY LOCATION, SIZE, TYPE, AND ACTIVITY
- CAN TAKE ACTION USING INDIRECT FIRES AND MANEUVER



TASK FORCE COMMANDER

COURSE OF ACTION

TACTICAL OPERATIONS CENTER

FSE

EXECUTE FIRE AND MANEUVER

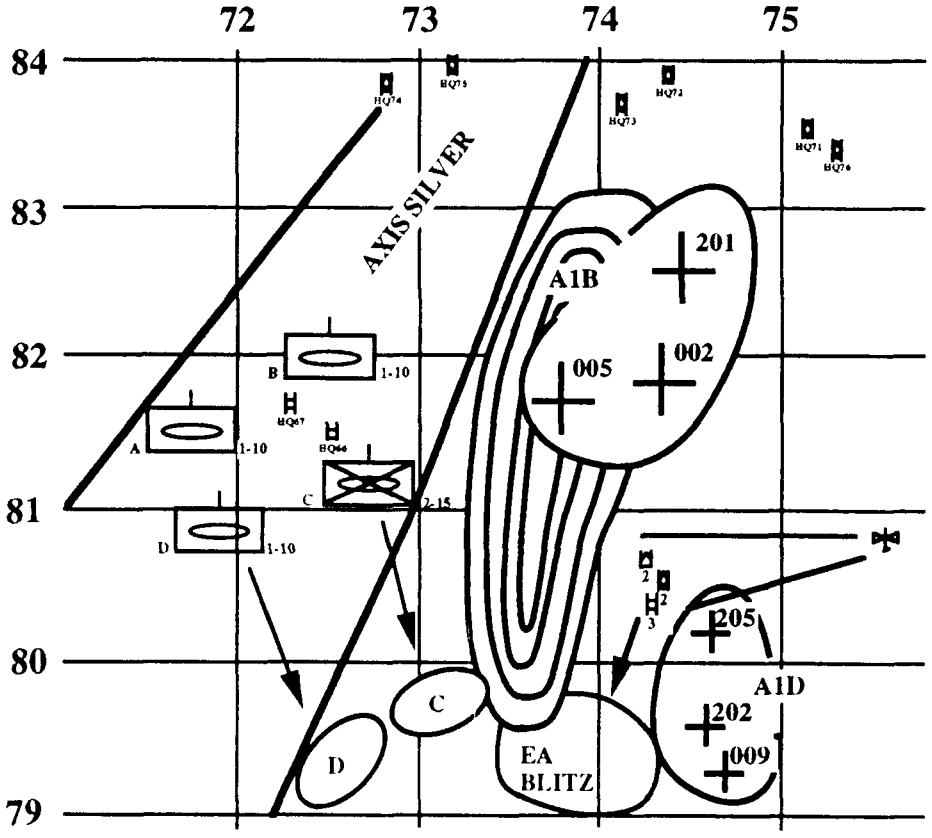


FIGURE C - 6. Target Handover Sequence

assets. The exchange of IVIS graphics and messages must be tempered against the current situation of forces engaged in combat, and must be in represented on a tactical display in a format that is meaningful to the execution of the mission, and is easy to understand and manipulate. Like the exchange of targeting data between tanks and fire support elements, the exchange of IVIS targeting data between aviation and ground forces must take advantage of the automation that systems like IVIS offer to combat crews in order to speed the exchange of critical, tactical data (see Figure 21). The IVIS used to support aviation and ground forces as they operate together provides the commander and his staff with a tool to coordinate the rapid maneuver that is required on the future battlefield. The ability to exchange near real-time situational information, both friendly and enemy, enables aviation and ground forces to mass quickly, improves synchronization of direct and indirect fires against the enemy, and provides supplementary information (through position location updates) that might assist in reducing the preconditions that lead to fratricidal incidents.